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PHOTOGRAPHIC CAMERAS AND ACCESSORIES

COMPRISING

HOW TO MAKE CAMERAS, DARK SLIDES, SHUTTERS,
AND STAND

WITH NUMEROUS ENGRAVINGS AND DIAGRAMS

EDITED BY

PAUL N. HASLUCK

EDITOR OF "WORK" AND "BUILDING WORLD"
AUTHOR OF "HANDYBOOKS FOR HANDICRAFTS" ETC. ETC.

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PREFACE.

THIS Handbook contains, in a form convenient for everyday use, a comprehensive digest of the knowledge of making photographic cameras and accessories, scattered over nearly twenty thousand columns of WORK—one of the weekly journals it is my fortune to edit—and supplies concise information on the details of the subjects on which it treats.

In preparing for publication in book form the mass of relevant matter contained in the volumes of WORK, much had to be arranged anew, altered, and largely re-written. However, it may be stated that the contents of this Handbook consist substantially of matter contributed by a professional photographer, Mr. Arthur Hands, Instructor in Photography at West Ham and Leyton Polytechnics, and he has also kindly read the whole of the proofs.

Readers who may desire additional information respecting special details of the matters dealt with in this Handbook, or instructions on kindred subjects, should address a question to WORK, so that it may be answered in the columns of that journal.

P. N. HASLUCK.

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PHOTOGRAPHIC CAMERAS AND ACCESSORIES.

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CHAPTER I.

PHOTOGRAPHIC LENSES AND HOW TO TEST THEM.

No branch of science has advanced more rapidly during the past decade than has that of photography. This, no doubt, is due to its great commercial utility, its extreme value as an adjunct in almost all other branches of science and art, and to the wonderful power of fascination it possesses over all who adopt it as a pastime. Having enthusiastic votaries in every business and every profession—learned scientists, clever chemists, and skilled engineers—there is little wonder that it has progressed by leaps and bounds until it now commands a leading position in the scientific world ; and there only yet remains to be developed and perfected the process of directly reproducing the colours of Nature to place photography still further to the front in the arts.

Perhaps one of the chief reasons of its present popularity is the attention that has been paid by inventors and manufacturers to the construction of the necessary apparatus employed in the production of photographs. The camera itself has naturally received the greatest amount of study, and every year sees it improved upon.

Photography, either as a pastime or a profession, is a most interesting and pleasing pursuit. Large numbers practise the art as amateurs, solely for the pleasure derived from the result of their labours. Many more would doubtless do so but for the comparative costliness of the photographic outfit, and it is the object of this book to meet the needs of such, by giving plain practical instructions for making the necessary apparatus, easily followed by anyone capable of using a few wood-working tools.

The lens is the most important part of a photographic camera, but few properly understand what its requirements are. There is no actual necessity for a novice to start with a high-class lens, for he will probably succeed equally well, in his early attempts, with a very inferior one. It is advisable, however, to buy the best lens that can be afforded, and, as the beginner's knowledge of lenses is probably of the crudest kind, the following information concerning the different varieties of lenses, and the work that can be done with them, should be helpful.

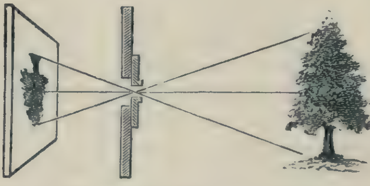


Fig. 1.—Diagram illustrating Light Rays.

It is quite possible to make a fairly good picture without the use of a lens; for instance, suppose that a darkened room is entered and that a hole is bored through the shutter of the window, and the edges bevelled off so that the hole shall not be tubular; on the wall opposite will be found an inverted image of the scene outside. For the sake of simplicity, suppose this "scene" to be a tree. From every point in the tree a ray of light emanates, passes through the hole, and lights up the screen with its own colour. Fig. 1 shows the direction of the rays and how the image is inverted. The room is a perfect camera obscura, and one that might be made practical use of in photography but for the reason that the hole in the shutter must have some diameter. If it be very large, then every spot in the screen opposite would receive light from all directions, and the images overlapping each other, the picture would be but poorly defined. The smaller the hole the sharper is the definition, so that fairly good pictures have been produced with an aperture made with the prick of a needle in tinfoil or other substance. But the difficulty is, that if the hole is made very minute in order to get a sharply-defined image, so much light is sacrificed that the image is but faintly illuminated, and the sensitive plate used in photography would have to be exposed for a great length of time. If the hole is enlarged and a suitable lens placed in it, the effect will be that, having a larger aperture, more light is obtained, and though the hole is considerably larger, all the rays of light will meet at a point, as shown in Fig. 2, which illustrates the simplest form of lens.

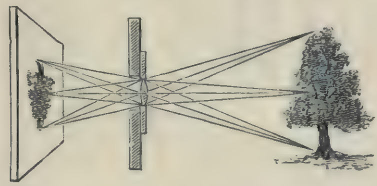


Fig. 2.—Diagram illustrating Principle of Simple Lens.

Simple lenses from which photographic and other combinations are built up are shown in section by Fig. 3, in which A is a double-convex or bi-convex; B is a plano-convex; C is a meniscus; D is a double-concave or bi-concave; E is a plano-concave; and F is a concavo-convex, sometimes incorrectly termed a concave-meniscus.

The photographer's single lens (Fig. 4) consists of two or more glasses cemented together and looking like one, fixed in a brass tube or "mount"; the negative element is of crown glass and the positive of flint glass cemented together with Canada balsam.

The lens must be fitted with stops of some kind; the simplest form of stop is a circular plate containing variously sized holes, which may in turn be brought before the centre of the lens. The stop may be an "iris" diaphragm, consisting of a series of overlapping plates, which, by turning a ring surrounding the lens mount, causes the hole to get gradually smaller; or it may be a number of little plates with different sized holes which drop in through a slot, these being called "Waterhouse diaphragms." They all give equally good results, but the "iris" is the more convenient. In front of this comes a projecting ring called the "hood," and at the back is screwed a metal "flange," with three holes for attaching to the camera front by wood screws. These lenses are suitable for landscape work or an occasional portrait in bright light, when they should be used with "full aperture" or the permanent stop. Single lenses give distortion, causing, for instance, square objects to be represented of the shapes shown in Fig. 5 or Fig. 6, the particular kind

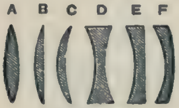


Fig. 3.

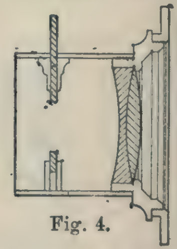


Fig. 4.

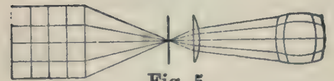


Fig. 5.

Fig. 3.—Simple Lenses; Fig. 4.—Single Lens; Fig. 5.—Distortion with Single Lens.

of distortion depending on the position of the stop either before or behind the lens.

Roughly speaking, there are three forms of doublet lenses: the "rapid rectilinear" (or "rapid symmetrical," "rapid rectigraph"), the "portrait" (Fig. 7 shows the Petsval or general form), and the "wide-angle." All three are really rectilinear, or non-distorting. Each has a compound lens at each end of the tube, and generally between them are stops of one of the forms named above; the distortion of one lens should counteract exactly that of the other, the result being rectilinearity, see Fig. 8. The rapid rectilinear is the most useful for all-round work. It is generally smaller in diameter than the portrait, but larger than the wide-angle. It is slower than the portrait—that is, its full aperture is less in proportion to its focus, and so allows less light to pass, thus necessitating longer exposure. In a doublet lens, either of the glasses may be removed and the

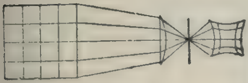


Fig. 6.

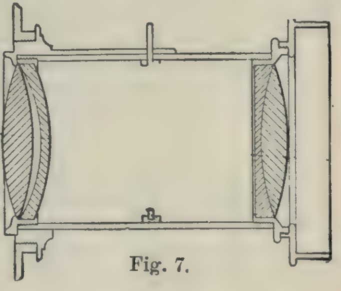


Fig. 7.

Fig. 6.—Distortion with Single Lens; Fig. 7.—Petsval Lens.

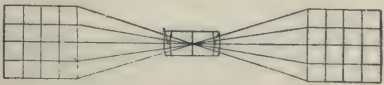


Fig. 8.—Rectilinearity with Double Lens.

other used alone as a single one, in which case it generally gives a lens of about twice the focus and covers a larger plate. When this is done it must be remembered that the value of the stops is proportionately altered ; in either case it is generally preferable to use the front lens. The rapid rectilinear is suitable for architectural or landscape work, and for copying and for portraiture where the light is good, and where clear definition is not objected to. For large heads the single lens is preferable. It does not usually distort, but in some cases there is a slight distortion, which will be detected by the second test described on p. 17. The portrait lens is the least useful for general work, as it is specially constructed to give good and soft definition over only a small area with a very large aperture. It is generally fitted with a rack and pinion, by which the lens tube may be moved backwards and forwards in an outer tube. Such lenses are expensive if they are good. Old-fashioned ones of French make are frequently met with second hand at a low price, but are generally of no value. The wide-angle lens is a rectilinear of short focus in proportion to the sharply defined disc it gives, or, in other words, the size of the plate it will cover. Such lenses are slow in action, and by exaggerating the perspective give a grotesque appearance to objects which become foreshortened. They are a necessary evil, and should only be used in confined spaces for architectural work. The loss of light at the margins is also a serious defect. The difference between the actions of wide and narrow-angle lenses may be gathered from Figs. 9 and 10.

From the foregoing it will be understood that any lens is a wide-angle if used to cover a plate whose diagonal is longer than the lens focus. For ordinary work the focus should be equal to the diagonal of the plate. The necessary lengths for a medium angle or focus are : quarter-plate, 5½ in. ; half-plate, 8 in.; whole plate, **11 in.**; 10 in. by 8 in., 13 in.; 12 in. by 10 in., 16 in. The single lens is the cheapest, and a good single lens is superior to a poor rapid rectilinear. When only one lens can be had, choose the rapid rectilinear. If two, the rapid rectilinear and the wide angle. It is an advantage, where only the rapid rectilinear is possessed, for the two glasses or "elements" to be of different foci.

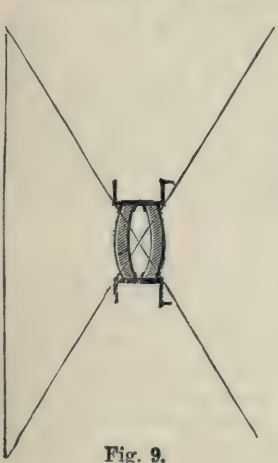


Fig. 9.

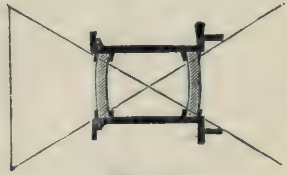


Fig. 10.

Fig. 9.—Wide-angle Lens; Fig. 10.—Narrow-angle Lens.

For example, if one is of very long focus and the other medium, then medium and narrow angles are given when each is used alone, a wide angle being given when they are used together. Unfortunately, the covering power often is inferior in the resulting combination, except in such cases as the Zeiss anastigmatic lens. It should be mentioned further that the rapidity of any lens depends entirely upon its ratio aperture or the proportion which the diameter of the largest stop that will give the desired sharpness bears to its focal length. The larger this stop is the more light will pass, and the quicker will be the lens. A common fallacy is to suppose that a whole-plate lens is necessarily quicker than a half or quarter-plate. There is no advantage in using the larger lens provided the smaller one covers with desired sharpness at the same aperture, and the use of the larger lens would cause more reflections in the camera, with possible loss of brilliancy in the picture.

When buying a photographic lens always have it upon approval, and then the following points should be tested for. It is a convenience to at once obtain some rough idea of the focus, and this may be done by focussing any distant object, measuring the distance from back of lens to plate in a single lens, or from diaphragm to plate in a doublet. If the stops are not marked their diameter, divided into the focal length, give approximately their proportionate value.

Fuller particulars on determining the focus of a lens may be of value. If a number of parallel rays of light fall upon the surface of a double convex lens, striking it at an angle, they will be refracted or bent towards the centre ray, and the point where these rays meet is the principal focal point. The greater the convexity or outward curvature of the lens, the more will these rays be bent and the nearer will this point be to the lens. The focal length is the distance from this point to the optical centre of the lens. The focus of a lens is the *nearest* point to the lens at which a sharp image can be obtained of a distant object. In the case of a single lens it is sufficient to focus an object at least 50 ft. away, and measure from the ground surface of the focussing screen to the back surface of the lens with a foot rule. In the case of a doublet or compound lens it may be ascertained in the same way, but it is then generally the "equivalent" and not the "back" focus which is required; or in other words, the focus of a single lens which would give an image of the same size at the same distance from the object. This is found with fair accuracy by the following method :—On a wall stick two strips of white paper, the outer edges of which are exactly 2 ft. apart (or make other marks which can be readily seen on ground glass), and focus these sharp one-fourth the original size, so that on ground glass they will be 6 in. apart. Then measure the exact distance from wall to screen. A weight attached to a piece of string and held in the plane of the ground glass will enable the exact distance to be measured along the floor. This distance has to be multiplied by the ratio or proportion of image to object, and the product divided by the ratio plus one and squared. Therefore, supposing the distance from wall to ground glass is 50 in., the working will be 50×4 (the ratio) $\div (4 + 1)^2 = 200 \div 25 = 8$ in.

Nearly all lenses sold for photography, unless exceedingly low in price, are achromatic ; that is to say, their chemical focus and their visual focus occur at the same distance from the lens. If this is not so, negatives will always be out of focus, no matter how sharp the image appears on the screen, owing to the rays of light which act most upon the photographic plate coming to a focus nearer the lens than those which most affect the eye. Consequently, the chemical rays have widened out again at the visual focus and surround each point of light with a halo. For the tests about to be described, a series of vertical and horizontal parallel lines forming squares is required. A chess-board with its squares numbered clearly may be used. The camera should be used on the edge of a table, and not on a tripod. Care must be taken to keep the board, camera front, and screen top absolutely parallel. Swing the back to a considerable angle. Focus the board roughly with full aperture about one-fifth size, and *accurately* focus a certain square near the centre. The slide should now be very carefully inserted and a plate exposed and developed. If this square is equally sharp upon it, the lens is achromatic. If, on the other hand, another square is sharper, the exact correction may be at once estimated. In all these experiments the dark slide must of course be in correct register with the screen; this is easily tested for by placing a sheet of ground glass in the slide, the rough side of the glass being towards the lens, in the exact position occupied by the plate.

For testing for covering power and flatness of field, the back should be placed strictly vertical and the chess-board again photographed, this time one-fourth its size with full aperture of the lens. The lens should be shifted as far as possible to one side of the camera, and only about half its field used. This is explained by Fig. 11, the right-hand side of the board being focussed at the left of the plate. If the camera front has not any side movement, the rising front should be shifted, the bottom row of squares being focussed along the top of the screen. The negative will show how far the definition extends, and this distance multiplied by two will give the circle in which the plate must be included. Say, for instance, it extends 2½ in. at *f*/8; that would give a circle of 5 in., which would be only large enough for a quarter-plate. At *f*/16 it extends 3½ in.; this would do for a half-plate. If possible, the lens should cover well at full aperture the plate to be used. It is a help if a similar photograph is at hand for comparison, taken with a lens of a known quality.

In endeavouring to correct roundness of field, lenses are often caused to show astigmatism. To detect this, pin two narrow strips of white paper at right angles across the board. Focus sharply in the centre of the screen the centre of the cross thus formed (moving the camera until it is exactly central with it). Move the camera sideways till the centre of the cross falls near the margins; if both vertical and horizontal lines are sharp at once the lens is correct, but if when the one line is focussed the other is indistinct, as will probably be the case with any but first-class lenses, the lens shows astigmatism. The amount may be gauged by the amount of extension required between the two foci.

Flare spot is a defect sometimes met with, and it may be detected by focussing sharply in the centre of the screen the flame of a lamp or candle ; if there appears a circle of light around the image, and if the circle remains in the same place regardless of the camera being moved round, the lens will show, on any negative taken under similar conditions, a round patch of fog in the centre. The lenses should be dusted before this test, and stops and tube should be carefully examined to see if they are thoroughly blackened. Flare spot may generally be remedied by a slight alteration in the position of the stop.

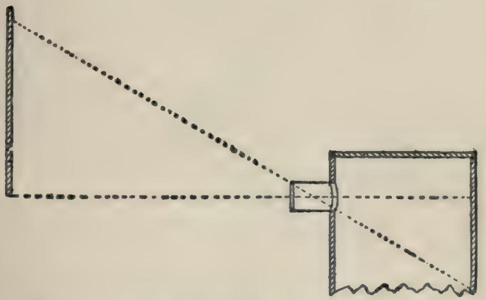


Fig. 11.—Testing Lens for Covering Power.

If a lens shows ghosts it may be detected in the following way. Focus the candle flame sharply at the extreme edge of the screen, and "ghosts" will be at once detected by a duplicate image appearing on the other side.

The depth of focus depends largely upon focal length and aperture, and may be estimated by the first test mentioned (see p. 17), seeing how many squares of the chess-board are in focus at one time with various stops. It is optically a defect, but is very desirable in some photographic work, notably hand camera work, groups, etc. The shorter the focus of a lens and the smaller its aperture in proportion thereto, the greater the depth.

Spherical aberration is a defect shown by a general diffusion of focus, and in portraiture is to an extent desirable. Focus the chess-board sharply with a medium stop. Now stick to the front of the lens—in the centre—a circular piece of paper the same size as the stop ; if any serious change in definition takes place, spherical aberration is shown, due to the rays transmitted through the margins of the lens coming to a different focus from the central ones. To estimate the degree of spherical aberration proceed as in the case of astigmatism (pp. 18 and 19). With such a lens it is sometimes advisable to focus with the working stop.

Scratches, air bubbles, or discoloration of glass may be detected by placing the lens upon a sheet of white paper. They scarcely ever affect practical working, but make it a very little slower—hardly recognisable in ordinary work. Many high quality lenses of Jena glass have air bubbles.

It will be gathered from the foregoing that the testing of lenses requires some little care, and in making these tests many things will become clearer to the novice.

The practical method of determining the distance from the lens at which to place the stop is to cut a length of cardboard tubing and in it fix the lens by springing in the tube a wire ring to form a shoulder for the lens to rest against, and then another ring to keep the lens squarely fixed in the tube. A slot must be cut along the tube at the bottom, and a card stop with a piece of wire attached placed in the tube flat against the lens. Focus a square sheet of type and it will be found to be sharp only in the centre. Move the stop slowly down the tube away from the lens by means of the wire and note that the definition spreads rapidly towards the margins, but as the definition spreads the square begins to assume the appearance of a barrel. The best position is that giving the maximum of covering power with the minimum of distortion, usually where the stop just illuminates the corners of the plate. As this position is not always possible, the following method may be substituted. Draw a square each side of which is equal to the focus of the lens, as F¹(Fig. 12), and a diagonal line H K, and from its centre erect a perpendicular J M equal to the focus; at M draw a line N O equal to the diameter of the lens. Now draw two lines from H and K through N and O until they meet at L. The distance from M to L is the distance required.

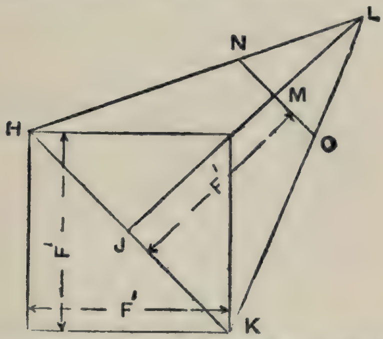


Fig. 12.—Determining Position of Lens Stop

Lens stops may be cut from sheet brass with a fret-saw to fit the diaphragm opening, afterwards blackening with dead black solution, for which see p. 48; or they may be cut from sheet ebonite.

Cemented lens may be parted in the following way: Lay a piece of wood in the bottom of a small saucepan and place the lens, which must have been removed from its cell, upon it. To do this it may be necessary to turn over the edge of the cell; but they are often screwed in with an inner rim. Warm water is then poured gently into the saucepan until the lens is covered. The saucepan then is heated gently and kept so until the lenses are found to slide easily apart. The old balsam may now be cleaned off with ether upon a silk handkerchief, but great care must be taken not to scratch the surfaces or injure the polish. Afterwards wash in soap and water. Be careful to remember which surfaces were together. When the lenses have been finally polished up with a wash-leather, a drop of best Canada balsam, baked until it has become hard, and then made hot so as to be thin enough for use, is applied to the centre of the concave surface and the other pressed down upon it till it spreads evenly. Warm the lenses before doing this. Now bind the two together with string, winding round and round in all directions. Heat the lens gently until the balsam is thoroughly hard, which may be ascertained by testing that which has oozed out at the edges. Remove the string and clean the edges with ether, and it will be ready for re-insertion in the cell.

CHAPTER II.

MODERN HALF-PLATE CAMERAS.

This chapter will deal with the construction of a camera which, while embodying all the more recent improvements and necessary movements to make it suitable for "all-round" amateur requirements, yet is simple and devoid of unnecessary or elaborate details. At the same time, it will close into very small compass and is of little weight, a matter of much importance, as every photographic tourist knows.

The camera, to serve for all purposes, must have the following movements: A reversing back, so that the dark slide with the plate may be placed in position vertically or horizontally at pleasure. The front-board, carrying the lens, must also have a vertical movement, as well as a movement from side to side. The camera must also have a swing back—that is to say, the rear part of the camera carrying the dark slide must be made to tilt forwards or backwards, to form an angle greater or less than a right angle in relation to the base-board, so that the picture shown on the focussing screen will be in focus from top to bottom, as when photographing tall buildings. The camera will require to be supported by a stand. Many persons unacquainted with photography, and possibly led away by such statements as "you press the button, etc.," fall into the erroneous idea that the hand camera is much easier to use, whereas it is usually found to be quite the reverse. The work of a hand camera is limited to instantaneous exposures which are only possible under favourable conditions as to light, subject, etc.

If a hand camera is chosen which may be used with a stand (such as the second one described in Chapter IV.) more scope is allowed, and good work may be done with the hand camera, it being particularly useful in crowded places or where the erection of a stand would be out of the question, whilst it is lighter and less conspicuous, but the stand camera can be relied on, and always produces better work.

The various sizes of cameras are denoted by the size of the plates or negatives which they accommodate, as—¼-plate, 4¼ in. by 3¼ in.; ½-plate, 6½ in. by 4¾ in.; whole plate, 8½ in. by 6½ in. Cameras are also made for plates 5 in. by 4 in.

The dimensions here to be given are for a half-plate camera, this being the most convenient and popular size with amateur photographers; but, at the same time, with a few simple calculations, anyone should be able to work out the necessary measurements to produce any other size—whole-plate or quarter-plate, for instance; these cameras, however, are treated separately in Chapters III. and IV. respectively.

Mahogany is the wood almost universally used in camera making, it being clean, easy to work, and lending itself admirably to the fine and accurate tooling required in some portions of the camera, without liability to split; it must, of course, be dry and well seasoned. Spanish mahogany of the "curly" variety should not be selected, as not only is it more difficult to work, but it is very heavy and brittle, and although figured stuff looks extremely nice when polished, it is liable to crack or chip with the slightest knock or fall. Many of the handsomest cameras in the market are almost useless for practical every-day work for this very reason, and, though eminently suitable for exhibition purposes, they are not to be recommended when they are likely to receive a reasonable amount of wear and tear. Choose, therefore, the Honduras or Mexican mahogany, and the straighter the grain the better, particularly for the body, posts, rails, etc.

The various parts of the camera comprise: Body, bellows and bellows frame, reversing frame and dark-slide rails, ground-glass frame, base-board and extension-frame rails, extension or travelling frame, front posts, front-board frame, front-board, brass fittings, and the dark slide; the latter will be dealt with in Chapter VIII.

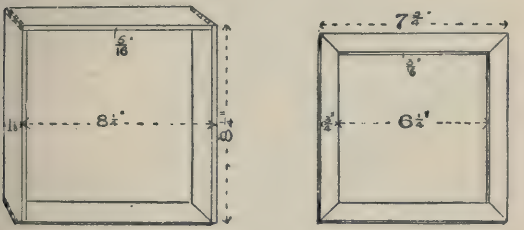


Fig. 13 Fig. 14.

Fig. 13.—Camera Body; Fig. 14.—Bellows Frame.

Roughly, the work will require about 3 sq. ft. of ⅜-in. and 1½ sq. ft. of ½-in. stuff, both "full" to allow for planing up.

The camera body should be made up first. For this four pieces of ⅜-in. stuff 8¼ in. by 1⅜ in. full must be planed up on one side only and carefully dovetailed, about three to the width, using for this and all other gluing-up purposes a mixture of 3 parts Scotch and 1 part best French glue; the glue must be well and properly made. The external portions of the body are now planed up level and square, and should finish 8¼ in. square by 1⅜ in. broad by 5/16 in. thick. Next plane a ⅜-in. bevel or round along one edge (see Fig. 13); this will form the bottom front edge of the body, and is made to allow it to clear the base-board freely when the camera back is swung out of the vertical.

The bellows frame must next be made. Take four pieces of ¼-in. or ⅜-in. stuff 8 in. by ⅞ in., mitre and plane to fit inside the body exactly; glue and key at the corners, and plane up one side only to bring it down to about $\frac{3}{16}$ in. thick, but allow the other side to remain rough as it leaves the saw. The frame should now measure about 7¾ in. outside and 6¼ in. inside (Fig. 14, p. 25). It is to be glued inside the camera body ⅛ in. from the back edge (farthest away from the bevelled edge), with its unfinished surface to the front. To this frame the bellows must afterwards be glued, and they adhere more firmly to a rough surface than to a smoothly-planed one.

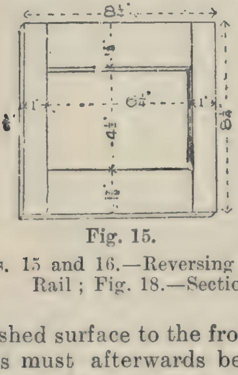


Fig. 15.

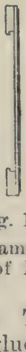


Fig. 16.

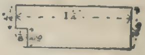


Fig. 17.

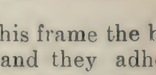


Fig. 18.

Figs. 15 and 16.—Reversing Frame; Fig. 17.—Dark Slide Rail; Fig. 18.—Section of Focussing Frame.

The reversing frame will require two pieces finished 8¼ in. by 1 in. by ⅜ in., and two pieces 6¼ in. by 1⅞ in. by ⅜ in. These are keyed and glued together to form a frame of the same external dimensions as the camera body, with a 6¼-in. by 4½-in. opening (Fig. 15). The dark-slide rails can then be got out: Plane up two pieces of wood 8¼ in. by ¼ in. by ½ in. stuff, and on each make a $\frac{3}{16}$-in. by ⅛-in. rebate, as shown in Fig. 17. Glue and screw these to the reversing frame, allowing 6 1/16 in. between the rebates, the utmost care being observed that they are fixed perfectly parallel, otherwise it will be difficult or perhaps impossible to insert slide. After cleaning up frame and rails to same dimensions as outside camera body, plane a rebate round the inside of reversing frame about ⅛ in. deep and 5/16 in. broad, to allow the frame to fit inside the camera body and rest against the bellows frame; and as it is necessary that it shall do this whether the opening is upright or horizontal, particular attention must be paid to everything being made absolutely square. The end view of the reversing frame is shown by Fig. 16.

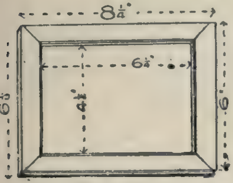


Fig. 19.

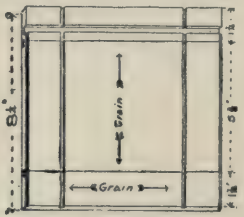


Fig. 20.

Fig. 19.—Focussing Frame; Fig. 20.—Base-board.

For the focussing frame that is to hold the ground-glass 3 ft. of grooving, as shown in section, Fig. 18, will be required. The rebate for the ground glass should be about ⅛ in. wide, and the same depth as thickness of glass, so that the latter will come flush with the outside of frame. This grooving is made out of ½-in. stuff, and is cut and mitred to form a frame to carry the ground glass, which will measure 6½ in. by 4¾ in., the external dimensions of the frame being 8¼ in. by 6⅛ in. It must now be planed up to measure exactly ¼ in. from inner surface to the ground side of the glass (the glass is always placed with ground or rough side nearest lens); the accuracy of this portion of the camera is of the utmost importance, as upon it depends the correct register of focussing glass and sensitised plate. A ⅛-in. tongue is next cut along the bottom of the frame to fit under slide-rail rebate, and the top of frame planed down until it will drop between the rails, but at the same time fit fairly tight. The frame will now appear as in Fig. 19, p. 27.

For the base-board take a piece of good ⅜-in. stuff 8¾ in. wide, and plane up the two sides to make it 5⅜. in. long; get out two pieces for clamps, 8⅜ in. with the grain by 1½ in. wide, plane up one side of each to closely fit the sides of the centre-board, and key to each side of centre-board. When the glue is set, plane up the base-board to 8¼ in. square, then plough out a groove $\frac{5}{16}$ in. wide by $\frac{3}{16}$ in. deep ¾ in. from front end of base-board for the pinion, and two grooves 1½ in. from the sides about $\frac{3}{16}$ in. wide by $\frac{1}{16}$ in. deep for the teeth of rack to run in. Finally, run a rebate down each side $\frac{3}{16}$ in. wide by $\frac{1}{16}$ in. (full) deep from back to pinion groove, which, when side rails are attached to base-board, will form a groove in which the shoulder of the side hinge-plates will slide. Fig. 20, p. 27, shows the position of grooves on base-board and method of clamping.

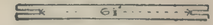


Fig. 21.

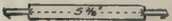


Fig. 22.

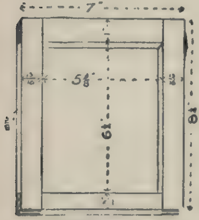


Fig. 23.

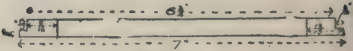


Fig. 24.

Figs. 21 and 22.—Finger-joints; Figs. 23 and 24.—Extension Frame.

The extension frame can next be got out; for it will be required two pieces 8¼ in. by 1 in. by ½ in. for the sides, one 7¼ in. by 1 in. by ½ in. for the front, and one piece 7¼ in. by ¾ in. by ½ in. for the back. Finger-joints are cut as shown in Figs. 21 and 22. The frame is glued up and then planed down to 8¼ in. by 7 in. by ⅜ in., the inside measurement being 6½ in. by 5⅜ in. (Fig. 23). Rebate each side ¼ in. deep by ⅛ in. wide, as shown in section, Fig. 24.

The side rails are made of ½-in. stuff finished 8¼ in. by $\frac{11}{16}$ in. A groove ⅛ in. deep by $\frac{5}{32}$ in. broad is cut down the side of each $\frac{3}{32}$ in. from bottom (Fig. 25) for the extension frame to slide in, and they are then glued and screwed to base-board, the extension frame being placed in position when doing so to ensure accuracy. The sides of rails and base-board are then planed level, and the upper face of rails and extension frame are treated in a like manner. A section of the base-board, side rails, and extension frame is shown in Fig. 26.

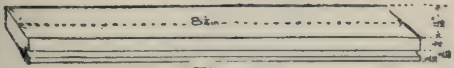


Fig. 25.

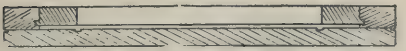


Fig. 26.

Fig. 25.—Side Rail; Fig. 26.—Section of Base-board and Side Rails.

The front posts lie inside the extension frame when camera is closed, so must not exceed these limits in length and width. The posts will measure 6½ in. by ½ in. by $\frac{7}{16}$ in., and must have a ⅛-in. groove ¼ in. deep down inner side ⅛ in. from front surface. The bottom or horizontal rail is $4\frac{1}{16}$ in. by 1 in. by $\frac{7}{16}$ in., and is keyed and glued at bottom of posts as illustrated in Fig. 27; a section through the posts is shown by Fig. 28.

The front-board frame is made to slide between the posts, mitred and keyed in the usual way, and measures, when finished, 4⅜ in. square outside by $\frac{11}{16}$ in. wide by ½ in. thick, and 3 in. square inside, with a rebate ⅛ in. by $\frac{3}{16}$ in. deep, into which the front-board drops (Fig. 29). The sides are then rebated to slide in the grooves in front posts, a section through side of frame when thus finished being given in Fig. 30.

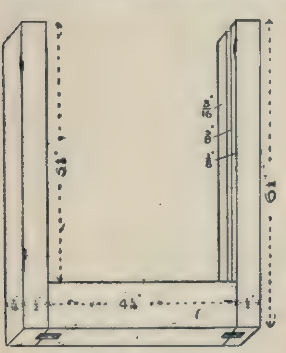


Fig. 27.

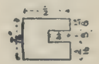


Fig. 28.

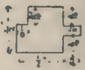


Fig. 30.

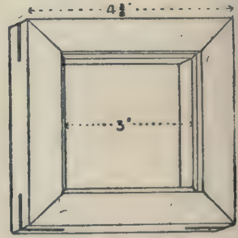


Fig. 29.

Fig. 27.—Front Posts; Fig. 28.—Section through Front Post; Fig. 29.—Front-board Frame; Fig. 30.—Section through Side of Frame.

The front-boards (of which one or more can be made, according to the number of lenses to be used with camera, see Chapter I.) are made of ⅜-in. stuff, keyed and clamped, and measure 3¼ in. square, with a ⅛-in. rebate to fit the front-board frame (see Fig. 31).

Before the camera is glass-papered off and polished, the two plug-nuts for the side struts and four for the side hinge-plates should be let in. Halfway up the side of the camera body, and ⅜ in. from the front edge, bore a $\frac{3}{16}$-in. hole, and tightly screw in the plug-nuts, as shown in Fig. 32, first dipping them in glue to render them immovable when screwed in position. Now place the side hinge-plates (Fig. 33) in the groove on edge of base-board, and mark off for two nuts on each side, one about 1½ in., and the other about 4¾ in. from back of base-board, the nuts, of course, being fixed directly under centre of slot through which the milled screw passes. The plug-nuts are then filed level with the wood-work, which is then ready for cleaning up.

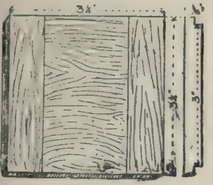


Fig. 31.

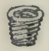


Fig. 32.

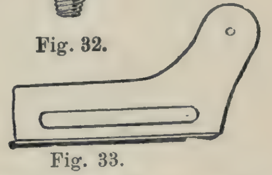


Fig. 33.

Fig. 31.—Front-board ; Fig. 32.—Plug-nut ; Fig. 33.—Side Hinge-plate.

When glass-papering, commence with No. 1½, laid over a cork rubber, and go over every part carefully—always working with the grain and never across—and round off all corners and sharp edges, using a fair amount of pressure. When that is done, give it a second turn with No. 1 paper, and finally go over it lightly and smoothly with No. 0, which will be all the better for the purpose if it has been used before upon some other job. On this final papering depends, to a great extent, the appearance of the finished camera, and the utmost care should be taken to avoid scratches or cross-grain work.

Lastly, the camera must be polished, after first darkening the colour by a slight application of chrome in an almost dry state, so as not to raise the grain. The whole of the woodwork must be polished, except the under-side of the extension frame (which is chromed and oiled only) and the inside of body, back of bellows frame, back of focussing-glass frame, and those parts of reversing frame covered by it, and the back of front-board frame and front-boards, all of which are blackened, as explained on pp. 48 and 49.

The illustrations (Figs. 34 to 62, pp. 33 to 40) show the fittings required for the camera. With the exception of Figs. 34, 49, 59, and 60, the whole of these fittings are of brass, the flat parts being cut out of hard rolled sheet, and the turned parts are what brass-founders term "fine yellow metal" castings.

The illustrations show the various fittings half-size, so there should be no difficulty experienced in making the different parts required; moreover, in many instances a slight modification in the size or shape of a particular fitting will not be of material consequence, although in every case the most serviceable and simplest form is illustrated. These fittings can all be purchased ready made, either in a rough or finished state, and the amateur camera maker will certainly find it more economical to purchase such parts as Figs. 34 to 38, 40, 41, 42, 52, and 53 ready for attaching to the camera than to make patterns for castings as otherwise will be necessary.

Fig. 34 shows the pinion, with knurled head and end bearing in position; the pinion wire can be either in brass or steel, the latter being by far the most durable and satisfactory. For a half-plate camera it should measure $\frac{1}{4}$ in. in diameter, and have ten teeth or "leaves"; it should be 7 in. long between shoulders, A, A, the shaft at each end being turned down to fit the holes in end and bridge bearings, each $\frac{1}{4}$ in. long by $\frac{5}{32}$ in. diameter. At one end a piece (B) must be filed, $\frac{1}{4}$ in. long and $\frac{1}{8}$ square, to fit the knurled head, and beyond that the pinion wire must be threaded about $\frac{3}{16}$ in. to fit the female thread in screw nut, see B, Fig. 34; the total length of the pinion wire from end to end is almost 8 in. The knurled-head (A, Fig. 35) may be of 1 in. to 1¼ in. diameter. It is drilled at the top to take the screw-nut (B, Fig. 35), and the hole in the neck filed square to fit the square shaft of pinion. The two bearings are shown in Figs. 36 and 37; the end plate (Fig. 36) should be about 1½ in. long by ½ in., with two screw-holes drilled and countersunk; it will present a more finished appearance if the edges are slightly bevelled, and the outside or exposed surfaces will, of course, require lacquering. The bridge bearing (Fig. 37) being let in flush with base-board and always hidden by the extension frame, requires no special finish; it must have two screw-holes countersunk from the flat side, the base-board being gouged out for the bridge to drop in. The pinion is now inserted through the hole at right side from back of base-board, and the end bearing screwed to edge of base-board and side rail as shown in Fig. 63, p. 42. Two lengths of brass rack (Fig. 38) now are required, having teeth cut along the edge to fit pinion wire. These racks measure 6½ in. long by ½ in. broad by ⅛ in. thick, and are to be screwed

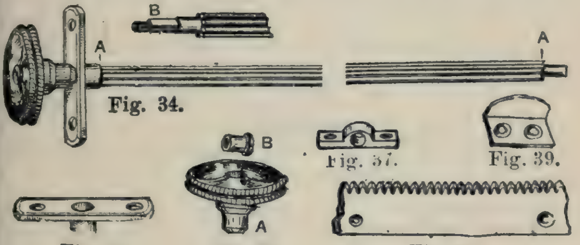


Fig. 34. Fig. 37. Fig. 39. Fig. 36. Fig. 35. Fig. 38.

Fig. 34.—Pinion; Fig. 35.—Pinion Head and Screw; Fig 36.—Pinion End-plate; Fig. 37.—Pinion Bridge Bearing; Fig. 38.—Rack; Fig. 39.—Extension-frame Stop-plate.

against the inside edge of side rails of extension frame; they must be drilled and countersunk about every 2 in. and finished and lacquered on the exposed surfaces. Some little care is necessary in adjusting the rack to work smoothly upon the pinion; the extension frame should be inserted in its place between the side rails, and the teeth of the rack applied to the pinion and then and there screwed to the frame. Care also must be observed that the teeth of the two lengths of rack are directly opposite each other, otherwise the pinion will be liable to jump and cause considerable trouble when the extension frame is being racked out; indeed, upon the nicety of the adjustment of the rack depends the possibility of obtaining sharp focus easily.

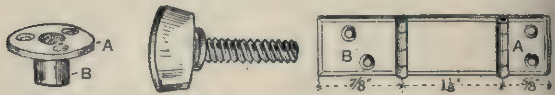


Fig. 40. **Fig. 41.** **Fig. 42.**

Fig. 40.—Base-board Nut; Fig. 41.—Tripod Screw; Fig. 42.—Knuckle Hinge.

The extension-frame stop-plate (Fig. 39, p. 33) can next be screwed to the base-board in the centre close to pinion. This L-shaped plate is made of 19 B. W. G. brass, finished and lacquered upon all sides except that resting upon base-board; its exact position will be clearly seen at A (Fig. 63, p. 42). It will be as well at this point to insert the base-board nut Fig. 40. This nut is of cast brass and is finished in one piece, the flange, A, being about $\frac{7}{8}$ in. diameter, drilled and countersunk for three $\frac{1}{4}$-in. No. 2 screws; the neck, B, is about $\frac{5}{16}$ in. long from under-side of flange by $\frac{3}{8}$ in. diameter, tapped to take the tripod screw (Fig. 41) having a $\frac{1}{4}$ in. Whitworth thread. Exactly in the centre of the base-board a $\frac{3}{8}$-in. hol is bored and the nut pushed through from above, t flange being screwed to the upper surface of the base-board. It will be necessary to chisel out the underside of back rail of the extension frame so that the latter will clear the nut when racking out. A better method of inserting base-board nut, but one entailing a little more trouble, is to let it in with flange flush with the base-board (as at B, Fig. 63, p. 42) before polishing, and then clean up and polish the woodwork ; it will not then be necessary to cut away any part of the extension frame.

The reversing frame and focussing-screen fittings now have attention. A pair of double knuckle-hinges (Fig. 42) will be required measuring $1\frac{1}{8}$ in. between the centres of joints, the upper wing being $\frac{5}{8}$ in. long and the lower about $\frac{7}{8}$ in.—sufficient to overlap the ground glass and thus retain it in the frame. The hinges should be about $\frac{5}{8}$ in. wide, and must be carefully finished and lacquered on the knuckle side, and if the edges are bevelled their appearance will be considerably enhanced. Holes must be drilled and countersunk in the necessary positions for screwing to top of reversing frame (A, Fig. 42) and face of ground-glass frame (B, Fig. 42), the latter being drilled as shown, so that both screws shall not enter the same grain in the wood. These double hinges should be attached to the camera with their outside edges about $1\frac{1}{2}$ in. from the sides of the camera body as shown at A, A, Fig. 64, p. 42, which also shows at B the position of the focussing-screen turn-button, Fig. 43, which

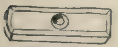


Fig. 43.

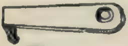


Fig. 44.

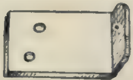


Fig. 45.

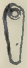


Fig. 46.

Fig. 43.—Focussing Screen Turn-button ; Fig. 44.—Reversing Frame Clip ; Fig. 45.—Reversing Frame Hook ; Fig. 46.—Turn-button.

measures about 1⅜ in. by ⅜ in. by 15 B.W.G., the reversing-frame clips (Fig. 44) C C (screwed to underside of camera body, finished and lacquered on exposed side only), and the reversing-frame hooks, D D, about 1⅛ in. long, with a right-angle piece about ¼ in. long; these must be drilled slightly out of centre so that the screw enters the end grain of camera body (as seen in Fig. 45). The hooks are made of 18 B.W.G. brass, 5/16 in. wide at broad end, tapering to about ⅛ in. or 3/16 in. The reversing-frame clips measure, before being bent, 1⅜ in. by ⅝ in. 15 B.W.G. ; about ¼ in. is bent at right angles, and the corners rounded. Fig. 43, p. 35, shows the turn-button and dark-slide stop, Fig. 44 the clip, and Fig. 45 the hook. Fig. 46 shows the clip which secures the ground glass in the focussing screen.

By using an American style of focussing screen it could be arranged to come away from the camera, and so allow of the insertion of the dark slide without swinging the screen right back. For this purpose four strips of brass will be required, as Fig. 47, 1 in. long and ¼ in. wide. These are screwed loosely to the sides of the screen frame, having been previously riveted to the bent plates (Fig. 48) at A. A hole, ¼ in. diameter, must be bored in the edges of two side pieces of the screen frame, and rods of vulcanised fibre or wood shaped to fit—allowing ½ in. projection. These projections go under the brass strips D (Fig. 49), which, however, does not show the fittings in position ; they keep the screen or slide in close contact with the velvet covering the reversing frame. The bent plates are screwed to the reversing frame, care being taken to get them very even and quite parallel. The lower part of the screen frame must be narrow, to allow of drop. The dark-slides —which are usually made with shutters of vulcanised fibre that pull right out—must have a projecting strip on either side along the bottom of the top rail. On the one side this fits into a groove cut to receive it in the reversing frame, and on the other it catches under the edge of the screen frame. E E E (Fig. 49) are rails against which the slide fixes. A spring catch F holds the reversing frame.

Next make the side-hinge fittings: A pair of hinge-plates (Fig. 50 and 51, p. 39) for right and left side of base-board will have to be cut from 16 B.W.G. metal, and have a $\frac{1}{8}$-in. shoulder bent at right angles to the plate to slide in the groove alongside of base-board. A pair of side struts (Fig. 52), also cut from 16 B.W.G. brass, 6 in. long, with a 4-in. by $\frac{3}{16}$-in. slot, are riveted to the extreme corner of the plates, as shown in the illustrations, and the upper lug of the hinge-plate is screwed to the body of the camera about $\frac{1}{2}$ in. from front edge and $\frac{1}{4}$ in. from bottom, B

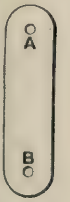


Fig. 47.

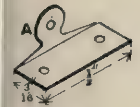


Fig. 48.

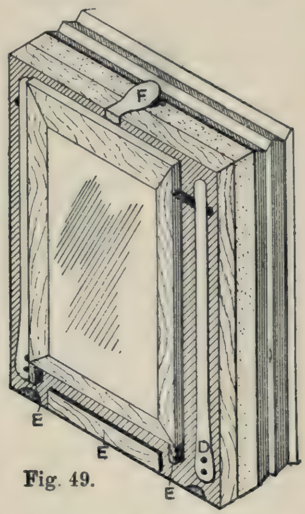


Fig. 49.

Figs. 47 and 48.—Fittings for American Focussing Screen; Fig. 49.—American Focussing Screen.

(Figs. 66 and 68, p. 43). Although not absolutely necessary, it will be advantageous to insert a small brass plate (see Figs. 65 and 68, p. 43) into the body of the camera flush with the woodwork at this corner, through which the round-headed screw attaching the body to hinge-plate is passed, thus providing a hard, smooth surface for the hinge-plate to work upon; the exact size of this plate, of course, is immaterial. Now slide the hinge-plates into the base-board grooves, close the body upon the base-board, and, after bringing the back of base-board and bottom of body level (as shown in Fig. 65) with a scratch-awl or other fine point mark upon the base-board the exact centre of the slot in the hinge-plates. Then push the body forward (as in Fig. 68, p. 43) as far as the pinion end-plate will permit, see the other side is exactly the same distance up the base-board (so that the back of camera is parallel with end of base-board), and make a similar mark this time through the back end of slot. Remove the hinge-plates from the grooves and let into each side of the base-board at these points two tapered plug nuts tapped inside and out (Fig. 32, p. 31), as show at c (Figs. 65 and 68, p. 43); insert the

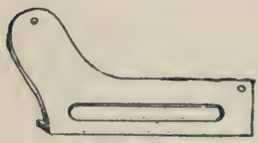


Fig. 50.

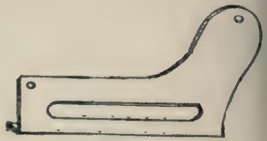


Fig. 51.

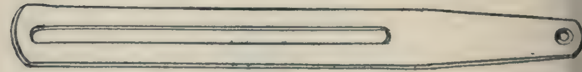


Fig. 52.

Figs. 50 and 51.—Side Hinge-plates; Fig. 52.—Side Swing Strut.

shoulders of the hinge-plates in the grooves, and, pass a milled-head screw (Fig. 53) through the slots into the plug-nuts and thus clamp the body of camera firmly to the base-board. A small screw should be put in the end of base-board grooves at D (Fig. 65, p. 43) to act as a stop for the hinge-plates and prevent the camera body being accidentally detached from the base-board. A pair of similar milled screws will be required to fit the plug-nuts in the camera body, at E, for the side struts.

This fitting, although so very simple as compared with many other patterns, combines every possible movement an amateur can need: it admits of almost unlimited vertical and horizontal swing, so essential when photographing buildings and similar subjects, and it permits the body of the camera being brought forward and fixed at almost any part of base-board —a movement of the utmost utility when lenses of short foci are employed. The body of camera can also be swung vertically when thus brought forward, which is not possible in many cameras.

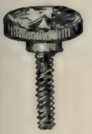


Fig. 53.

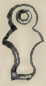


Fig. 54.

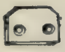


Fig. 55.

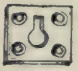


Fig. 57.

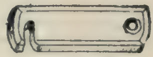


Fig. 58.

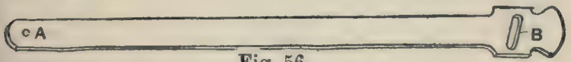


Fig. 56.

Fig. 53.—Milled-head Screw; Fig. 54.—Front Board Turn button; Fig. 55.—Front-board Plate; Fig. 56.—Front Clamping Bar; Fig. 57.—Keyhole Plate; Fig. 58.—Fastening Clip.

The fitting of the camera front, yet remaining, is not very difficult. A couple of finished turn-buttons (Fig. 54) and one or two plates (Fig. 55) are screwed to the front-board frame, as at A A A (Fig.

67, p. 43), to retain the front-board, B. The clamping-bar (Fig. 56), made from 18 B.W.G. brass, measures 4½ in. from screw-hole, A, to centre of slot, B, and is attached to the front posts by two round-headed screws in such a position that when raised as high as the slot will permit (C, Fig. 67, p. 43), the front-board frame can be raised or lowered, but when the end of the clamping-bar is pressed down the front posts are drawn together and the front-board frame thus held firmly in position. The projecting end of the clamping-bar must be bent over as seen in Fig. 67, p. 43, otherwise the front cannot be closed inside the extension frame.

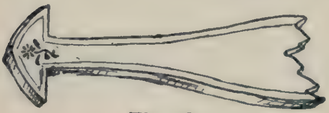


Fig. 59.

Fig. 61.

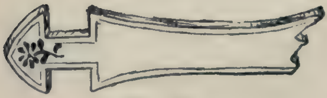


Fig. 60.

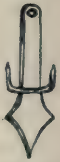


Fig. 62.

Figs. 59 and 60.—Strap Handles; Fig. 61.—Strap Handle Bridge; Fig. 62.—Pummet and Wire Bridge.

The keyhole plates must next be attached to front of extension frame. The ordinary form is shown in Fig. 57, p. 39. An improved and patented form is bent at right angles and has an L-slot cut in the side. The pair of keyhole plates, preferably of the improved form, are screwed at C C (Fig. 63, p. 42), the wood underneath being gouged out to leave space for the round-headed screws which pass through the keyholes. Two ⅜-in. No. 3 round-headed screws are now screwed into underside of front-post rail, at D D (Fig. 67, p. 43), being so placed as to drop into the keyholes, and, when pushed along the slot of keyhole, hold the front posts in a vertical position. Whilst thus fixed two similar screws, E E (Fig. 67, p. 43) are passed through the extreme end of the L-slot in upright wing of the improved keyhole plate and screwed down fairly tight. By this means all possibility of the bellows dragging the camera front out of the vertical is insured against, but the addition of a bevelled strip of mahogany glued and screwed to the foot of front posts at the back of the bottom rail F (Fig. 67, p. 43), will make absolute rigidity doubly secure. The method of fixing up the camera front will now be obvious: the necks of the screws are dropped through the holes in the improved key-plate and mouth of L-slot respectively, and with a slight lateral movement slide along the slots; while, to detach, this movement is simply reversed and the front post lifted off the plates.

The hook (Fig. 58, p. 39), which is screwed to top of camera body in the centre, should next be made, and a round-headed screw fixed in end of base-board, so that the base-board and body can be held together when closed. This should be made of rather heavy brass—say, 14 B.W.G.—and must measure about $1\frac{1}{8}$ in. from screw-hole to notch.

A leather handle for carrying is also a useful addition; there are several designs for these, two of which are shown in Figs. 59 and 60. A pair of brass bridges—such as is shown in Fig. 61—for the strap handle will be required, and a plummet or spirit-level can be affixed according to the fancy of the camera maker. Fig. 62 shows a plummet and wire bridge.

The construction of the camera will be simplified by reference to Figs. 63 to 68, pp. 42 and 43. Fig. 63 illustrates the base-board and extension frame, with pinion racks, stop-plate, base-board nut, and patent keyhole plates fitted, whilst Fig. 64 shows the reversing back, with double hinges, focussing-screen, turn-button, clips, and clip hinges fitted. Fig. 65 is an end view of the camera closed, with hinge-plates, side struts, clip hinges, and pinion. In Fig. 66 the camera is at full extension, showing the front erected. Fig. 67 shows the camera back brought forward for wide angle lens, with extension-frame partly racked out. Fig. 68 is a view of the camera front, showing position of clamping-bar, turn-buttons, and screws for keyhole plates.

There now only remains to be added the bellows.

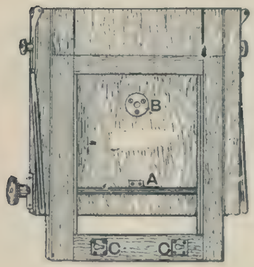


Fig. 63.

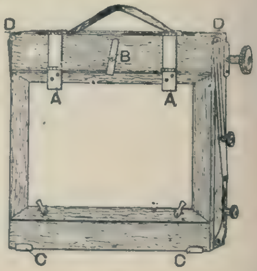


Fig. 64.

Fig. 63.—Baseboard and Extension Frame; Fig. 64.—Reversing Back.

These are of the conical shape and measure outside 7½ in. square at back, 3⅞ in. square at front, and extend to about 15 in. The last two or three folds at back should be made parallel and not conical, otherwise there will be a liability to cut off part of the view when the bellows are used at short extension. Probably, it will be found much cheaper and perhaps more satisfactory to purchase the bellows ready-made; but the following instruction on bellows making is full and reliable. In fitting the bellows, they are cut at the corners so that the outside folds lie flat, without creases; the back fold is then well glued, laid upon the bellows frame, and rubbed in contact for some time until the glue is set; and the other end is attached to the front-board frame in the same manner. If this is carefully and thoroughly done, screws and other arrangements are not necessary.

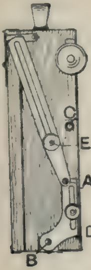


Fig. 65.

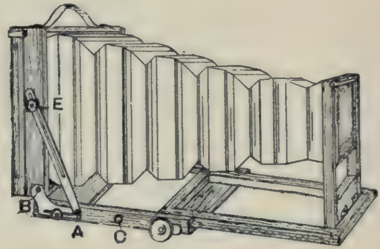


Fig. 66.

Fig. 65.—End View of Camera; Fig. 66.—Camera Extended.

In making square bellows first cut out a pattern in paper, so that when the more expensive material is being used, it may be worked up with confidence and without damaging it. Procure sufficient black lining and leather (morocco is best) for the size of

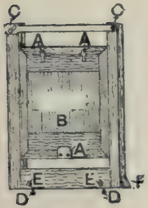


Fig. 67.

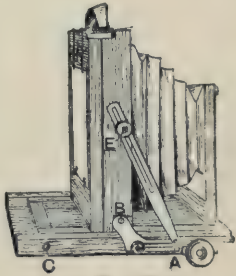


Fig. 68.

Fig. 67.—Back of Camera; Fig. 68.—Side View of Camera.

the bellows contemplated and cut out a rectangular piece of lining that, when folded, will be of the right dimensions. Upon this attach, with strong bookbinders' paste, the leather, which has been previously rendered limp by damping. Wherever it is necessary for the leather to overlap, it should be shaved sufficiently thin with a sharp knife to make the double thickness equal to the rest. Mark the position of the folds with a chalk pencil, as in Fig. 69. Before the leather gets quite dry, proceed to fold it fan-fashion, each fold to be 1 in. in depth, as in Fig. 70. Then place under pressure. When the material is nearly dry, fold it the contrary way, four sharp creases, as shown by the lines B B B B, to form the corners of the bellows. Now open it out and securely paste together the two ends of the strip in the centre of one side in preference to making the joint at one corner. There will now be formed a tube, as Fig. 71, consisting of leather outside and lining inside. This is pressed into shape with the fingers and thumb. The corners will be the only part likely to give much trouble, and must be pinched up, as in Fig. 72. All the corners being finished in this manner, press together and let them remain till absolutely dry to make the folds

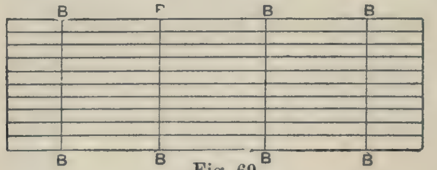


Fig 69

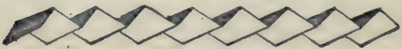


Fig. 70.

Fig. 69.—Pattern for Square Bellows; Fig. 70.—Camera Bellows; First Fold.

retain their form. When dry, work the bellows backwards and forwards until it is pliable and ready for attachment to the camera frame. It must be borne in mind that the space inside must be equal to the size of the plate to be used; thus, if the folds are 1 in. in depth, an outside measurement of an inch larger each way will be necessary, so that the fold will not cut off the light from the plate when in use, and only slightly extended. Half an inch or so must be left for joining up.

Another way of making square bellows is to employ strips of cardboard, which are covered with bookbinders' cloth or black twill. Cut a number of strips of cardboard an inch wide and 7 in. long, also a similar number $5\frac{1}{4}$ in. long, and slope off all the ends as in Fig. 73, p. 46. On a flat table lay a piece of cloth of sufficient size for the bellows, coat it with strong paste, and lay on the strips of card, nearly touching each other: 14 of the longest, then 14 shorter, then 14 long, and again 14 shorter, as in Fig. 73; let them dry, then paste another layer of bookbinders' cloth over them, the card strips being sandwiched between. When nearly dry, fold them up after the manner of a fan and put under pressure till quite dry; then, first of all, crease them sharply and longitudinally in each part where the ends of the shorter cards meet the longer; bend the whole into a tube, and glue the edges together. When the glue is thoroughly dry, pinch up the corners, and

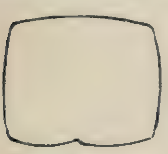


Fig. 71.

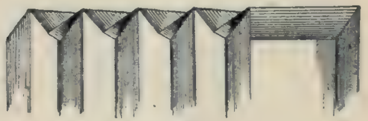


Fig. 72.

Fig. 71.—Section through Bellows; Fig. 72.—Folded Bellows.

the bellows are complete, ready to be glued into the back and front frames, to which they are secured by screwing on additional strips of wood.

For making conical bellows, use as before leather and black twill joined with a mixture of 4 parts of thin glue and 1 part of flour paste, the latter rendering the glue less likely to crack. Two thicknesses of twill should be used. About 1¼ yds. by ¾ yd. each of leather and twill will be required. Pin the material face down on a table, and draw a line A A (Fig. 74) in the centre of one edge. From the centre of this line erect a perpendicular B B 20 in. long. At the top draw a line C C at right angles on both sides 5 in. long, and then draw lines joining the points C A and C A. The angles for other sides are found as follows: With a blunt compass, taking care not to pierce the material, describe a circle with centre A and any radius. Where the circle intersects C A as centre, and where it intersects A B as radius, strike the arc D E, and draw a line 9¾ in. long through A E to F. At the top proceed in the same way (from C to G is 5 in.), and join the points G F. The other sides are ruled in the same way, except that

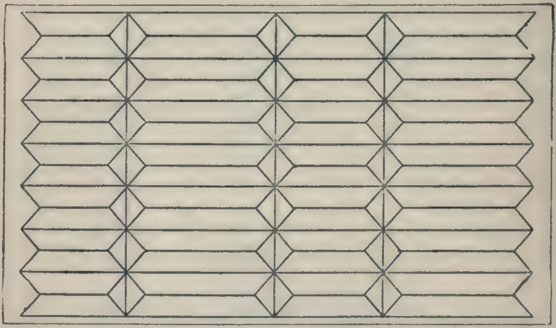


Fig. 73.—Cardboard Strips for Square Bellows.

the joined side is divided into two parts as shown. The material overlaps ½ in. all round to allow for joining. Lines should then be ruled parallel to each base line at 1 in. apart (see diagram). This may be done with a T-square by pinning the material loosely at upper B. Whilst in this position, the fold lines are ruled with a set-square. If the T-square be placed parallel with a line with the set-square on it, the inside edge will give an angle of 45°—the direction of required line. The lines H I J K, etc., will each be rather less than ¼ in. shorter to allow of taper. In this case there would be about twenty-one folds. When the strips of card and black twill have been attached in place, and the outside edges of twill trimmed to shape of leather, the bellows may be joined up to form a cone and the sides bent into shape with the fingers, the narrower spaces going in. A trial on a piece of paper is recommended. The lines bending inwards require ruling with a hard

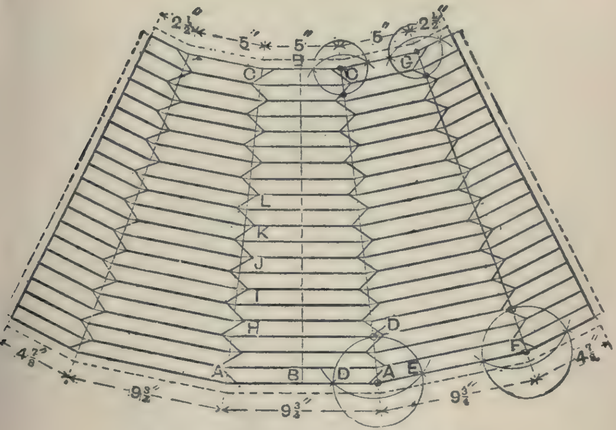


Fig. 74.—Pattern for Conical Bellows.

point. It is advisable first to practise the ruling and creasing on some brown paper.

For blackening the interiors of bellows, use methylated spirit in which some resin or shellac has been dissolved, and then lampblack added. The liquid, if shaken before use, should dry a dead black, which should not be removed on rubbing; more shellac or resin must be used if the black rubs off. It is applied with a brush.

A good dead black for the interior woodwork of a camera is made by dissolving 1 oz. of shellac and ½ oz. of borax in 20 oz. of hot water; when the shellac is quite dissolved add about 1 drachm of glycerine and sufficient aniline black (soluble in water) to form a good solid black. This is applied with a fine camel-hair brush, and a couple of coats are sufficient to produce a rich velvety dead black, that neither rubs off nor produces particles of black dust, so troublesome in some cameras and dark slides.

Another recipe is: Aniline black, 100 gr.; gum shellac, 200 gr.; methylated spirit, 5 oz. Dissolve thoroughly, and apply with a soft brush quickly. Negative varnish mixed with powdered lampblack may also be used. An excellent blacking for wood or leather may be made by mixing lampblack and French polish. The quantity of the latter must be only sufficient to make it adhere properly when dry. It is best applied with a flat camel-hair brush. Too much polish will result in a shiny surface. The best way is to mix it in a saucer to the desired consistency (thinning with methylated spirit if necessary), and try from time to time upon a piece of wood until exactly right. The best results are obtained with home-made blacking freshly mixed.

To blacken camera brass-work, first clean with fine emery or sand, wash, and immerse in a saturated solution of nitrate of copper. After about two minutes, take out and heat over a Bunsen burner or ordinary spirit flame. Repeat this several times. Copper nitrate may be made by dissolving 1 oz. of copper filings in 2 oz. of nitric acid. The filings should be added to the acid in the open air, and stirred with a glass rod till as much as possible is dissolved. If the whole of the article is to be blackened, suspend with a hook of copper wire. When blackened, rub over with a greasy rag. To blacken zinc-work in a camera, clean and wash as before, then prepare a solution of chloride of copper 45 gr., nitrate of zinc 30 gr., and water 4 oz., to which is added ½ oz. of hydrochloric acid. Immerse the zinc in this, wash and dry.

Tin fittings are blackened with carbon black mixed with sufficient French polish to make it adhere properly; more polish makes the black glossy. Another good formula is 1 oz. of water, 15 gr. of borax, 30 gr. of shellac, 15 minims of glycerine, and 60 gr. of nigrosin. Boil till dissolved, then add the nigrosin.

CHAPTER III.

WHOLE-PLATE AND STUDIO CAMERAS.

In this chapter the construction of whole-plate and studio cameras will be considered.

The whole-plate camera shown by Fig. 75 has been selected as comprising all necessary qualities, whilst it is simple in form. The back is made to swing from the bottom, a plan to which some take exception, preferring the centre as the fulcrum; but for all practical purposes it answers very well, and is very convenient in use. A corresponding strut on the opposite side of the camera to that shown keeps the whole firm, the inclination of the back being secured by aid of the milled head screw nut, A, the

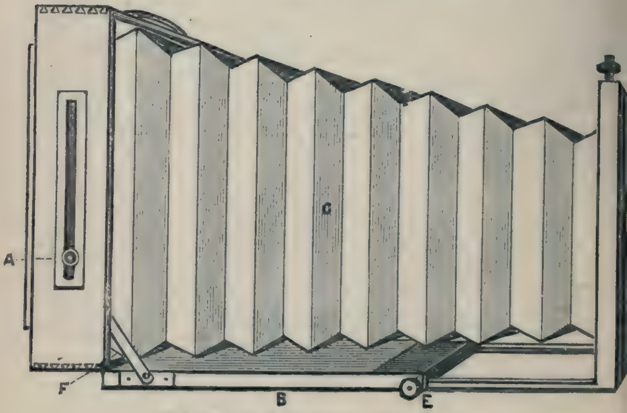


Fig. 75.—Whole-plate Camera Open.

screw itself being attached to the strip of metal F, which works on a pin on the side of the baseboard, B. The bellows, C, extends to about 23 in., and closes up to about 3½ in., making it suitable for either long or short focus lenses. In place of the usual plan of raising or lowering the lens, a revolving disc is fitted to the front, working in a rebate, and kept from falling outwards by four small metal clips. The milled head attached to a pinion is for the purpose of shortening or lengthening the bellows. Fig. 76 shows the camera closed for carriage.

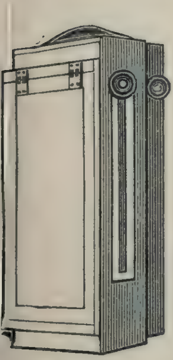


Fig. 76.

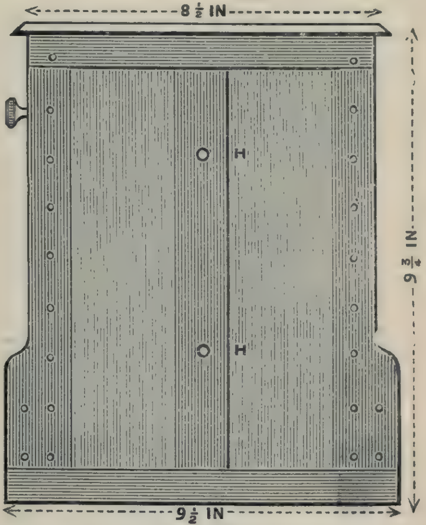


Fig. 77.

Fig. 76.—Whole-plate Camera Closed; Fig. 77.—Underside of Baseboard.

Having a supply of well-seasoned ½ in. and ¼ in. mahogany begin with the baseboard, which it is necessary to make firm and strong, not only because it is the platform on which the body of the camera has to be built, but also because it is the part by which the camera is attached to the tripod, and is, of course, subject to great strain. In Fig. 77, p. 51, the baseboard is shown carefully framed and clamped, in order to prevent the slightest warping, which would seriously interfere with the working of the sliding frame, which regulates the length to which it can be drawn out. In common cameras the baseboard is merely clamped at each end. Fig. 77 shows the underside of the baseboard, with the framing and small brass screws, about 1 in. apart; these screws attach the strips shown in Fig. 78, these strips forming guides for the sliding frame, Fig. 81. Fig. 79 is

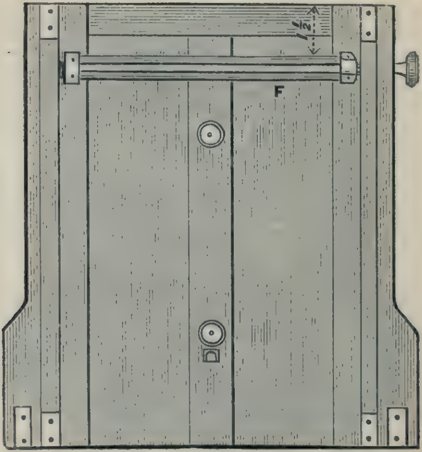


Fig. 78.

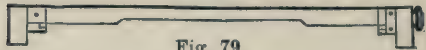


Fig. 79.

Figs. 78 and 79.—Upperside and Section of Baseboard.

a section through the baseboard, whilst Fig. 80 is a side view. The dimensions being given on the illustrations, it is unnecessary to state them here. Fig. 81 represents the upper side of the sliding frame, the inside edges of which are bevelled to improve the appearance. Two brass strips, B B, ½ in. wide and $\frac{1}{16}$ in. thick, are screwed to the frame along each outer edge, projecting $\frac{1}{8}$ in., and act as runners, so that the racking in or out of the bellows may be smooth and even. The ends of the strips near the hinges, C C, are slightly rounded, and similar strips, only much shorter, are placed over the ends of the hinged bar, D. Fig. 82 shows the underside of the

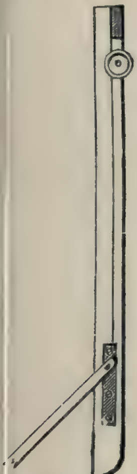


Fig. 80.

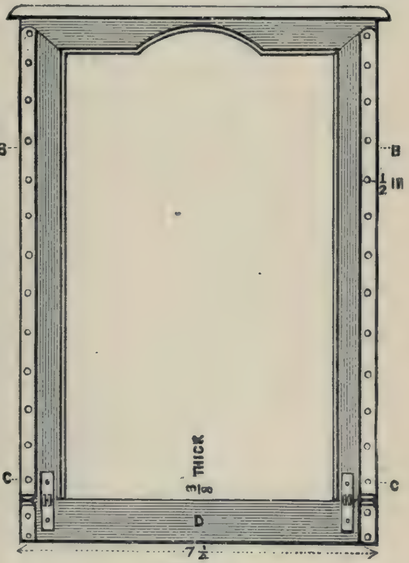


Fig. 81.

Fig. 80.—Side View of Baseboard; Fig. 81.—Upperside of Sliding Frame.

sliding frame and the two brass racks, A A; when put in place these engage with the pinion, F, in Fig. 78, actuated by the milled head at the side, G, Fig. 78. The screw plates, H H, are for the purpose of attaching the camera to the stand; by having two screw plates as shown a better balance is obtained, selecting one or the other, as the camera is used with long or short extension. Fig. 83 is a side view of the sliding frame, showing the curved joint, whch permits the easy folding of baseboard when closing the camera. The kind of hinge used is illustrated by Fig. 84.

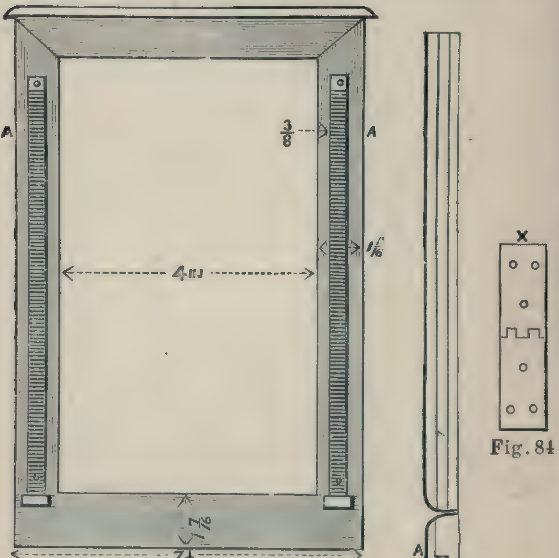


Fig. 82. Fig. 83. Fig. 84

Figs. 82 and 83.—Underside and Side View of Sliding Frame; Fig. 84.—Hinge.

Fig. 85 represents the back frame of the camera,

A being a metal plate with a slot in the centre, in which works a pin attached to the brass strut, Fig. 86. The notch, B (Figs. 85 and 87), is useful to indicate when the back is truly at right angles to the baseboard. The slotted plate is shown separately at Fig. 87. The pin resting in the notch shows that the plate-holder is in its proper place. It saves a considerable amount of trouble in adjustment when the back is not required to swing. The frame, E, Fig. 85, is for the purpose of getting true register with the focussing screen and dark slide; it is sunk ¼ in. below the outside frame, and has strips of black velvet glued on its face. Two small brass plates, C C, retain the slide and framing screen in close contact at the lower part, and two hinged catches, D D, at the top do the same for the upper part, and merely have to be turned back to take out or replace the frames. F F are small notches cut in the frame,

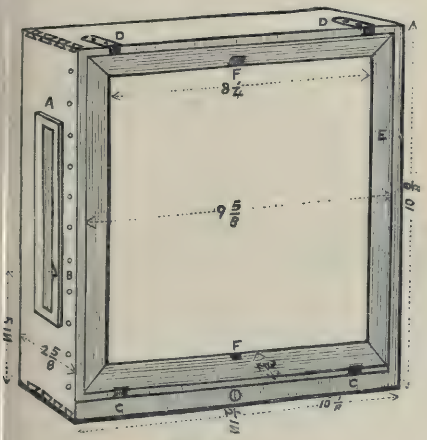


Fig. 85.

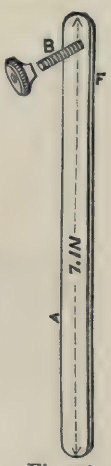


Fig. 86.

Fig. 85.—Back Frame; Fig. 86.—Brass Strut.

bound with brass plates, for use when the dividing screen, Fig. 88, is required. This screen consists of two strips of wood, B B; on one side of each is a

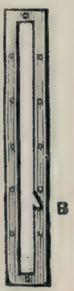


Fig. 87.

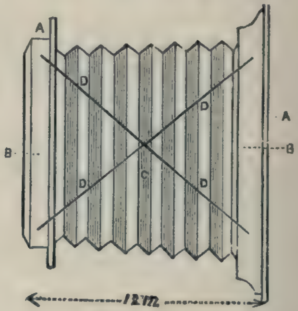


Fig. 88.

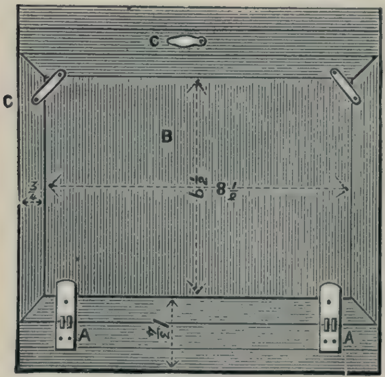


Fig. 89.

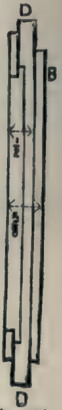


Fig. 90.

Fig. 87.—Slotted Plate; Fig. 88.—Dividing Screen; Figs. 89 and 90.—Front and Side Views of Reversing Frame and Focussing Screen.

strip of brass, A A, projecting ¼ in. beyond the wood, to do duty as buttons. These are connected together by a screen, folded zigzag, made of two thicknesses of black calico, and one of brown paper pasted together. D D D D are elastic cords on each side of the folds to keep them from bulging when not stretched to their full extent.

Fig. 89 shows the reversing frame, one of the most useful additions, permitting an oblong plate to be used either lengthways or upright without altering the camera. Fig. 90 is a side view of the frame, which is light and made of ¼ in. wood, to which the focussing screen is attached by folding hinges. The usual plan is to have the hinges at the top, and lift up the screen to insert the dark slides; but by reversing this arrangement and having the hinges at the bottom, the focussing glass is less in the way. C C, Fig. 89, are small brass strips to retain the focussing glass, B, in its place; a shred of cork is placed between the strips and glass to prevent movement. The folding hinges, A A, by projecting a little over the glass, answer the same purpose on the opposite

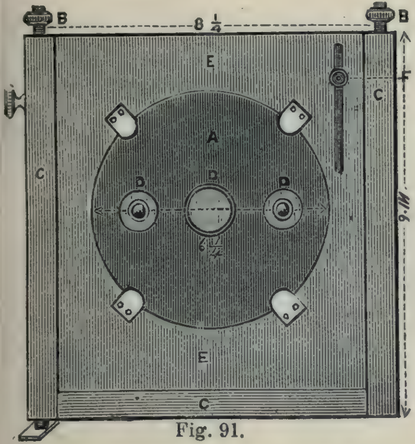


Fig. 91.

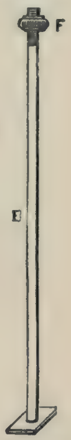


Fig. 92.

Fig. 91.—Camera Front; Fig. 92.—Screwed Pin.

side. The projecting fillet, B, Fig. 90, p. 56, is for the purpose of making the frame light-tight. D D, Fig. 90, is the part of the frame that fits in behind the plates, C C, in Fig. 85, p. 55. Fig. 91 shows the front of the camera. The frame, C C C, is made of ½ in. wood, E E being ⅜ in. The two pins, B B, pass down a groove in the back of the uprights, C C; a small plate attached to the end of the pin fits into the groove formed by brass strips at the bottom, and is pinched tightly by the nut, F, Fig. 92. The pin and plate are shown separately by Fig. 92. E E, Fig. 91, is the front, in which is cut a circular hole with a rebate, in which works the flanged disc, A, Fig. 91. For convenience the rebate may be formed by building up the front of two thicknesses of ¼ in. wood, the circular hole in the inner one being a little smaller than the outer. E E is lined at the back with ¼ in. wood; a smaller aperture in it than in the front piece forms the rebate, and covers the groove cut in C C, boxing in the pins, B B; the narrow ends of the bellows are fastened to E E with strips of wood, glue, and a few small screws. The conical bellows, Fig. 93, is fastened to the inside of the frame, Fig. 85, p. 55, in the same

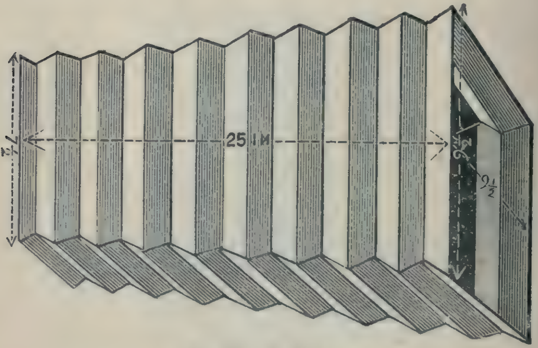


Fig. 93.—Bellows.

manner, as near to the front as possible. The disc, A, Fig. 91, p. 57, is provided with apertures for three lenses. This gives an opportunity for using two

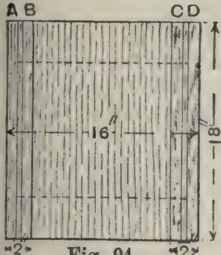


Fig. 94.

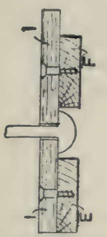


Fig. 95.

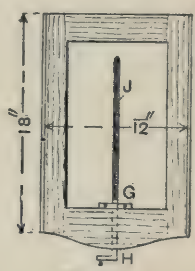


Fig. 96.

Fig. 94.—Studio Camera Baseboard; Fig. 95.—Section of Slotted Rail; Fig. 96.—Extension Frame.

small lenses for stereoscopic or lantern pictures, or a larger one for the whole size of the plate; also, by using a lens in one of the side apertures, a quarter turn will raise or lower the lens at will, or if the

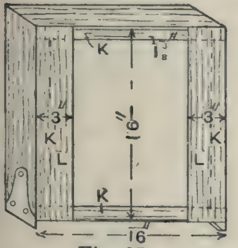


Fig. 97.

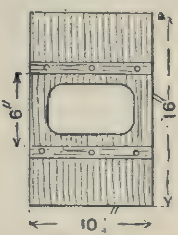


Fig. 98.

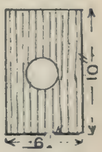


Fig. 99.

Fig. 97.—Sliding Frame; Fig. 98.—Rising Front Board; Fig. 99.—Sliding Front.

front containing the disc is made to work in grooves in the uprights, a slot C C and the side screw will permit the front to be raised without altering the central lens. Of course caps must be provided for all the lenses, those not in use being kept covered. The bellows is made of leather, over which black lining has been pasted (see pp. 46 and 47), each fold being $1\frac{1}{4}$ in. deep. There should be only one corner to join ; an inch extra in the width will provide for the overlap. Having fitted on the bellows, the inside of the camera is blackened, the outside French-polished, and the camera is complete when the dark-slides and shutter for it have been made (see Chapters VIII. and IX.).

A studio camera to take 12-in. by 10-in. plates may be made of $\frac{3}{8}$-in. mahogany. First construct the baseboard (Fig. 94, p. 59) of the size shown in the illustration, by tongueing together. Then make two strips E and F (Fig. 95) 16 in. by $\frac{3}{4}$ in. by $\frac{3}{16}$ in., and glue and screw these in the spaces A and B (Fig. 94). They will then be $\frac{1}{2}$ in. apart, and extend 2 in. from the edges, and stand up $\frac{3}{16}$ in. A strip I $2\frac{1}{4}$ in. by 16 in. is next strongly attached, as in Fig. 95, with a $\frac{1}{4}$ in. slot for a clamping rod running from about 2 in. or 3 in. from each end. A similar slotted rail is then made to come over C and D (Fig. 94). Next form the extension frame (Fig. 96) to run freely in the grooves of the baseboard rails. Fit the focussing screw J (which may be purchased ready prepared for about 4s.) by screwing down the bolt G to the baseboard, and the nut to the end of the extension frame at H. Construct the sliding frame (Fig. 97) by dovetailing four pieces each 16 in. by 3 in. Inside this fit a frame K $1\frac{3}{8}$ in. wide, flush with the front edges, and screw across two grooved pieces L for the rising front, 3 in. by 16 in. The rising front board may next be got out, with the two rebated rails for the sliding front ; this is sufficiently explained by Fig. 98. The sliding front or lens board is shown in Fig. 99. Now make the back frame (Fig. 100), giving about $\frac{3}{8}$ in. slope to the top and bottom to allow of swing. These four pieces, $14\frac{3}{4}$ in. by 3 in., are dovetailed together. Then sink the nuts for the thumbscrews B^2 and the pivots A^2. Inside the framework fit carefully a framework M exactly ⅜ in. from the back edge, and 1 in. wide; cover it with velvet on the near side. It is an advantage to bevel the frame towards the centre to allow of central expansion of bellows when closed. Proceed to fit the clamping rods N (Fig. 101). These consist of a long screw and nut, but the thread O need only extend about 1 in. P is a circular plate to grip the side rail, Q a washer, and R the thumbscrew or clamping nut. The bellows is made according to instructions in Chapter II., or

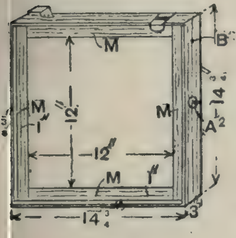


Fig. 100.

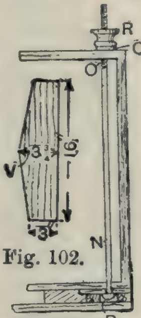


Fig. 102.

Fig. 101.

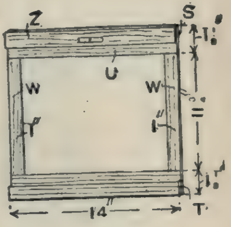


Fig. 103.

Fig. 100.—Back Frame; Fig. 101.—Frame and Clamping Rods; Fig. 102.—Side View of Fixed Frame; Fig. 103.—Reversing Back.

may be obtained ready-made. Glue the front of the bellows to the framework L, Fig. 97, and the back to the frame M, Fig. 100, and put under pressure till thoroughly dry. The fixed frame, shown in side view by Fig. 102, is prepared 16 in. by 3¾ in. The back frame is fitted with the pivots to the fixed frame at V, and the whole is then made up and screwed firmly to the back of the extension frame. Now make the reversing back (Fig. 103) by first joining up a frame of four pieces, and across them glue and screw two strips S and T $1\frac{1}{8}$ in. by 14 in., with $\frac{1}{8}$ in. groove at U. A further strip (not illustrated) may be fitted across between the two at W to form a stop for the slide. This must all be done in $\frac{3}{16}$-in. stuff to make the frame exactly $\frac{3}{8}$ in. thick when finished. The focussing screen frame is formed as in Fig. 104. The tongue X engages with the groove U, and the $\frac{1}{16}$-in. rebate Y is for the focussing ground glass which is held in by narrow strips of brass across the corners. Attach the screen frame to the reversing back by double hinges at Z Z.

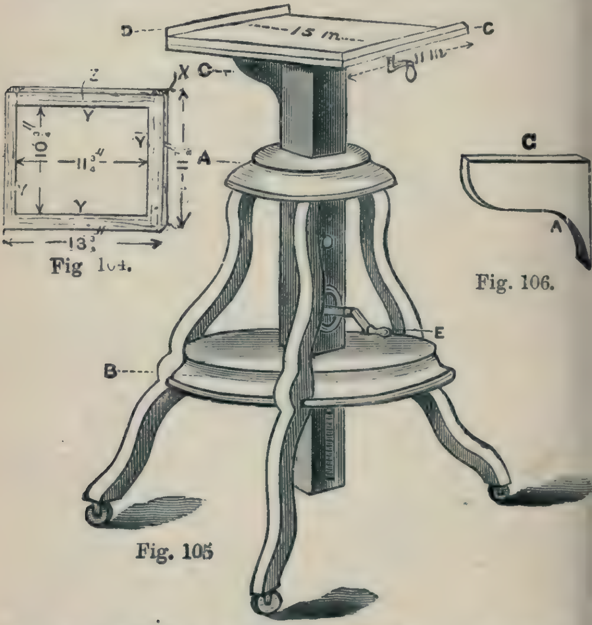


Fig 104.

Fig. 105

Fig. 106.

Fig. 104.—Focussing Screen Frame; Fig. 105.—Studio Camera Stand; Fig. 106.—Bracket for Top of Stand.

The ordinary studio camera stand (Fig. 105) combines to some extent the portability of the tripod with the solidity and firmness of the table stand, being supported on three stout legs mounted on castors, for moving readily. The double tilting stop, C (Fig. 105), measures 15 in. by 11 in., the wood being $\frac{3}{4}$ in. thick. The hinged part of the double top has a ledge, D, to prevent the camera slipping off when tilted. The lower part is supported on a bracket, G, whose shape is shown by the enlarged view (Fig. 106). The upper circular platform A, and lower circular platform B, are shown separately by Fig. 107. In Fig. 105, E is the handle by which the pillar on which the top rests is raised or lowered. Fig. 108 shows the double top, hinged in front, and raised or lowered by a wooden hand-screw or a winch and screw. The iron screw is 5 in. long, and say. $\frac{1}{2}$ in. in diameter ; each half of the top should be clamped to prevent warping.

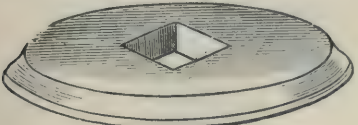
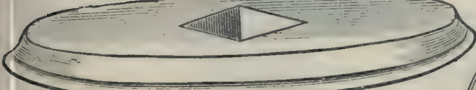


Fig. 107.



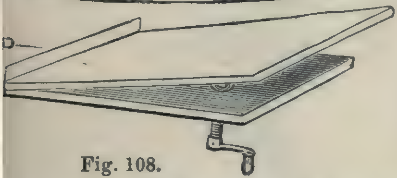


Fig. 108.

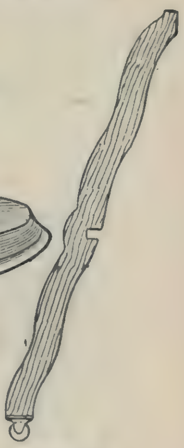


Fig. 109.

Fig. 107.—Stand Platforms ; Fig. 108.—Hinged Top of Stand ; Fig. 109.—Leg of Stand.

For the legs of the camera stand cut out three pieces of wood, 2½ by 2 in., as in Fig. 109; they may be straight is desired, but the curves improve their appearance. The length from above the castors to the top is 3 ft. 4 in., and the height of the first circular platform from the ground is 18 in. The upper circular platform A (Fig. 105) is of 2 in. wood, and is 8 in. in diameter. The lower one B (Fig. 105) is of 2½ in. wood, and 15 in. in diameter; both of them are nicely shaped at the edges, and have square holes cut through the centre, just large enough to allow easy passage of a solid pillar of wood (Fig. 110), 2½ in. square and 3 ft. long; the lower part of the tilting top is screwed firmly to this pillar, which is let in about ¼ in. One side is provided with a

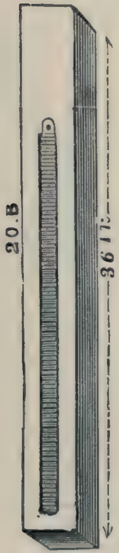


Fig. 110.

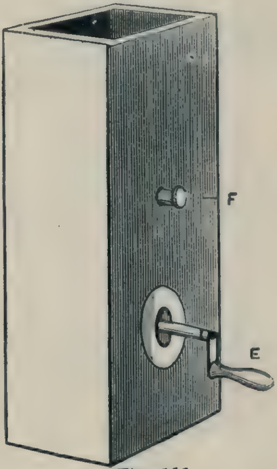


Fig. 111.

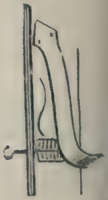


Fig. 112.

Fig. 110.—Stand Pillar with Rack; Fig. 111.—Stand Pillar Casing; Fig. 112.—Spring Catch for Stand.

strong iron rack about 20 in. long as shown in Fig. 110, and this, when it is fixed in place, engages with cog wheels attached to the winch handle, E, on the outer case (Fig. 111) for the purpose of raising or lowering the table. In order to prevent movement by the weight of the apparatus after the table has been raised to the required height, a strong wooden hand-screw or spring catch (Fig. 112) is fixed on the inside of the thin casing, which, engaging with the rack, prevents any downward movement. By merely pulling the knob F the rack is set at liberty, and may be lowered by the winch. The casing is made of $\frac{3}{4}$ in. wood, neatly joined, and extending between the upper and lower platforms, increasing the firmness and rigidity of the stand, and of just sufficient size internally to permit the pillar moving easily through it, not forgetting to allow sufficient space for the cog wheels and winding arrangements. As this entirely depends on the size of the castings, it cannot be definitely stated; three of the sides can, at any rate, be flush with the square holes in the platforms. A small bracket, Fig. 106, p. 62, attached to the pillar under the table is an advantage, as there is considerable strain on this part when using heavy apparatus. With the exception of the pillar and casing, all sharp edges should be taken off the work. The whole should be well polished, and the castors attached. The stand then is complete.

The winch screw and rack should be of the very best quality; otherwise, they are liable to cause considerable annoyance. The strain upon them when carrying a large camera is very great—in fact, so much trouble has been experienced with them that one well-known photographer has adopted instead the principle shown in Fig. 113. The method there illustrated has its drawbacks, and increases the weight of the apparatus; but it certainly possesses many advantages. To move the camera, loosen the screws A A, and it may be immediately placed at the desired level, higher or lower, without the least effort, as the weight B exactly balances the camera. Except when moving, the screws must be kept tightened, particularly when removing the

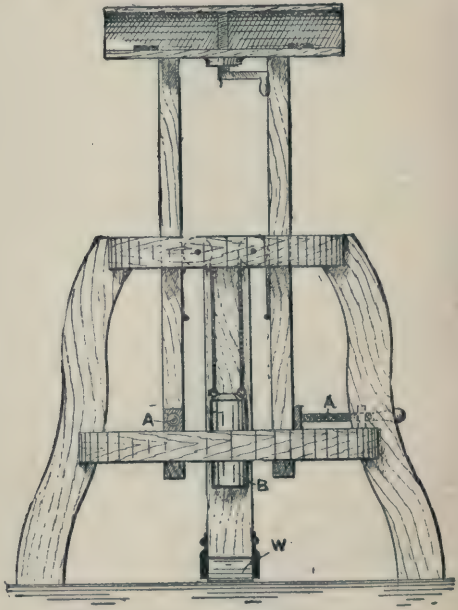


Fig. 113.—Studio Camera Stand.

camera from the stand. The essential thing is t have the camera run easily, and this is best don with one broad wheel W in the front leg, in whic case two handles should be fitted at the back to lif it by. This arrangement will be found of th greatest assistance when working upon linoleum covered or polished floors.

CHAPTER IV.

HAND AND POCKET CAMERAS.

THIS chapter will be devoted to describing the construction of two types of camera, a quarter-plate magazine hand camera and a pocket camera suitable for either hand or stand.

In designing the magazine hand camera an attempt has been made to avoid anything complicated or beyond the capability of the ordinary amateur. The method of plate-changing is very simple and is not liable to get out of order.

The size of the camera is 10⅞ in. long, 6 in. deep, and 5 in. wide. Its capacity is twelve ¼-plates in sheaths, and it is fitted with a finder for upright or oblong pictures. Mahogany is undoubtedly the best wood of which to make such a camera, but a straight-grained and thoroughly dry piece of whitewood will be almost as serviceable as mahogany. All sappy wood must be rejected, and great care must be taken to get everything true and square. For the body of the camera, procure two pieces 10⅞ in. long, in. wide, and ¼ in. thick; these form the sides. Two more pieces, 4 11/16 in. wide and the same length as the other two, will also be required; these form op and bottom. These are all the actual finished izes, so in cutting them out care must be taken to llow for waste in planing, etc.

Before going further the maker must decide how he body is to be put together; the square joint is nsatisfactory, owing to the liability to let in stray ight, but three kinds of suitable joints are illus-rated in Figs. 114, 115, and 116. The first (Fig. 114) s a rebated joint, made by sinking a rebate in the engths cut for sides, this rebate being ¼ in. on the

6-in. way and $\frac{3}{32}$ in. deep; both top and bottom o sides must be rebated in the same way. The piece forming top and bottom will then be square-edged and must be well glued into the rebate. The secon joint (Fig. 115) is formed by grooving the piece forming the sides with a $\frac{3}{32}$-in. groove, to the dept of $\frac{3}{32}$ in. also; then by cutting a tongue on eac edge of top and bottom a strong light-tight joint i made. Fig. 116 is somewhat similar, and is mad by grooving both the sides and the edge of top an bottom and inserting a cross tongue. If this plan i used the top and bottom must each be reduced t

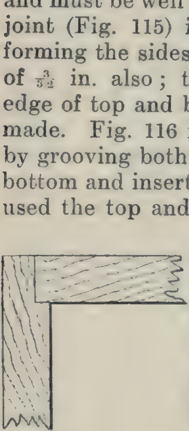


Fig. 114.

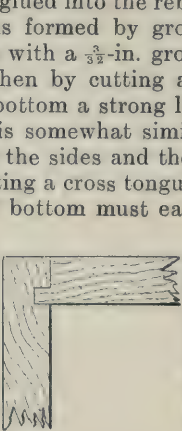


Fig. 115.

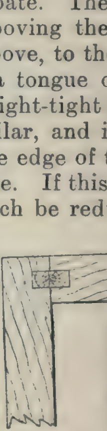


Fig. 116.

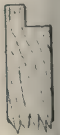


Fig. 117.

Figs. 114 to 116.—Joints in Camera Body; Fig. 117.– Tongued End of Body.

4½ in. wide, as in the sizes given above; $\frac{3}{32}$ in. eac side has been allowed for forming a tongue, or fillin the rebate in the first case.

Now at one end of each piece cut a tongue $\frac{3}{32}$ i thick and ⅛ in. long, as Fig. 117. When the body put together these will project at the back to fit int a corresponding groove in the piece forming t back. It would be as well now to knock the bod together temporarily; the inside size should now exactly 4½ in. wide by 5$\frac{7}{16}$ in. deep; if wrong, look f the mistake and rectify it before going any furthe Now knock it apart again, and cut grooves in ea of the sides $\frac{1}{16}$ in. deep, as shown in Fig. 118, takin care to set them out in pairs—that is, so that whe they are put together the grooves will come opposite each other. The longitudinal groove at A is for the shelf on which the plates stand before and during exposure, and is $\frac{1}{8}$ in. wide, $\frac{1}{16}$ in. deep, and of the length marked on Fig. 118, which is a quarter full size, so that all other dimensions may be taken from it. This groove must not be cut right through to the end of the side, but must be stopped as shown, or the greater part of the tongue left for back would be cut through. The measures are taken from the extreme length of the tongue. The other groove to be cut is marked D. B and C are not grooved.

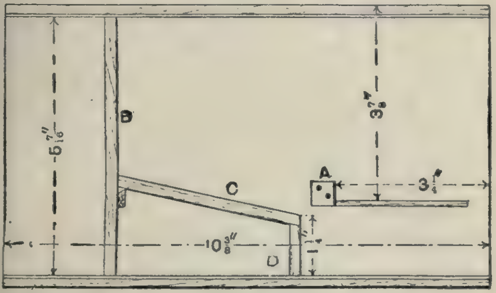


Fig. 118.—Section of Magazine Hand Camera.

Two pieces of brass must now be made as shown in Fig. 119. Two screw-holes should be made in the square portion ; the wing which turns at right angles should be $\frac{7}{32}$ in. wide and $\frac{5}{16}$ in. long. These catch the bottom corners of the sheath and prevent the springs pushing it too far in the camera. These of course must be made in a pair, one for each side. They may now be screwed into place with two $\frac{1}{4}$-in. screws, so that the bottom of the wing comes level with the bottom of the shelf, leaving $\frac{3}{32}$ in. projecting above ; these are represented at A (Fig. 118). Cut a shelf $4\frac{5}{8}$ in. long, $3\frac{1}{8}$ in. wide, and $\frac{1}{8}$ in. thick ; cut a piece out of each end $\frac{1}{16}$ in. by $\frac{1}{4}$ in. to allow for the bit not cut out in the sides. A piece, $4\frac{5}{8}$ in. by $1\frac{1}{4}$ in. by $\frac{1}{4}$ in., must also be prepared to fit in the other groove marked D. The piece for the top must now be cut across $3\frac{1}{4}$ in. from the end the tongue has been worked upon. In each of these new edges a $\frac{1}{16}$-in. plough groove, $\frac{1}{4}$ in. deep and $\frac{1}{16}$ in. away from the inside face, must be cut, as shown in Fig. 120. In the centre of each of these pieces make a recess $\frac{1}{32}$ in. deep and $\frac{7}{8}$ in. long in such a manner that when the two pieces are put together there will be a slot $\frac{7}{8}$ in. long and $\frac{1}{16}$ in. wide in the centre across the top. Obtain a piece of brass, $\frac{1}{16}$ in. thick, 2 in. long, and a bare $\frac{1}{2}$ in. wide; drill a $\frac{1}{16}$-in. hole exactly in the centre of the plate, and two others $\frac{1}{2}$ in. distant from the *outside* of the centre hole. Enlarge the centre hole until it is a slot $\frac{3}{16}$ in. long and $\frac{1}{16}$ in. wide (this may be done with a small punch), and slightly countersink the top side of the other two holes (see Fig. 121). Prepare another piece of brass, $\frac{1}{16}$ in. thick and $\frac{1}{2}$ in. wide, and shape it as shown in Fig. 122. Rivet this into the piece shown in Fig. 121 (with the wide part downwards) by means of the two outside pins, and if necessary add a little solder to make a firm job of it. This should now slide nicely in the plough groove. It will be found that the recess cut in the top pieces will require cutting about $\frac{3}{16}$ in. more each way on the inside face to allow the narrow part of Fig. 122 to move to each end alternately of the $\frac{7}{8}$-in. slot. This piece should be bent over, as shown in Fig. 120, to form a small knob projecting about $\frac{1}{8}$ in. above the outside of top; the bottom should be bent back, as shown in Fig. 120.

The body of the camera may now be well coated with hot glue on the joints and carefully knocked together, with the exception of the $3\frac{1}{4}$ in. that was cut off the top, which should be left out for the present. Be careful to have all square, and do not forget to glue the shelf and the other narrow piece in before putting the second side on; for it will be impossible to get them in afterwards. Allow at least a day for this part to get dry, then proceed with the work. Put the brass piece (Fig. 121) into the slot made for it, the bent part towards the back, push it to one end of the $\frac{7}{8}$-in. long recess, and fill up the remainder of the groove with a cross tongue

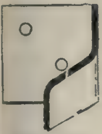


Fig. 119.

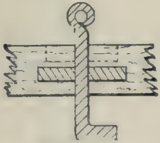


Fig. 120.

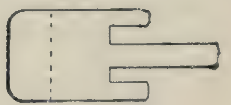


Fig. 122.

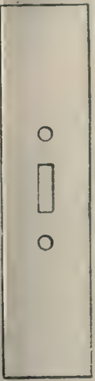


Fig. 121.

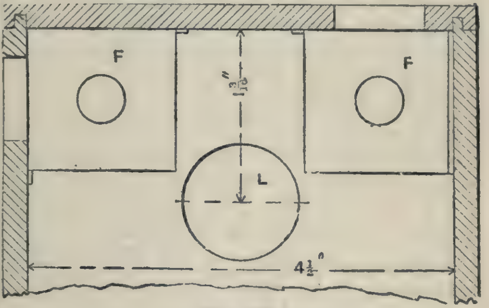


Fig. 123.

Figs. 119 and 120.—Sheath Stops; Fig. 121.—Top Stop Sliding Plate; Fig. 122.—Tongue of Top Sheath Stop; Fig. 123.—Lens Board.

Serve the other end the same. Of course, the tongues must be left long enough to fill the grooves in the other piece. If the brass slides easily when the other piece of the top is in its place, the tongues and edges of the top piece may be glued and the top completed. To avoid any chance of stray light, it is best to sink a bit of wood a bare $\frac{1}{8}$ in. thick and $\frac{3}{8}$ in. wide along the joint from each end of the $\frac{7}{8}$-in.

slot to the side of the camera. This is shown by the dotted lines in Fig. 120. Prepare two pieces 3⅝ in. long, 3⅛ in. wide, and $\frac{1}{16}$ in. thick, and one piece 4⅜ in. long, 3⅛ in. wide, and $\frac{1}{16}$ in. thick. The two first pieces are glued and bradded on each side of the body inside from the shelf to the top, so as to reduce the width to 4⅜ in. exactly. The other piece is glued and bradded to the top of the camera inside, reducing the height between shelf and top to 3$\frac{9}{16}$ in. These allow the sheaths just to pass easily; but after they pass out of this chamber there is $\frac{1}{16}$ in. each side clearance, so that they will not stick in the camera. A piece of zinc 3⅛ in. long and 1¼ in. wide may now be bradded inside the top in the centre across the grain of the lining piece that was put in last; this will allow the sheaths to slide without catching into the grain of the wood.

Now prepare the lens-board, which is 5$\frac{7}{16}$ in. deep, 4½ in. wide, and ¼ in. thick (it is assumed that a lens of about 5-in. *back* focus will be used, as this will be most easily obtained). Fig. 123 is a half size plan of the lens-board, L being the lens, and F the view finders. Cut a hole the size of the lens (probably about 1⅛ in. diameter) 1$\frac{13}{16}$ in. from the top, and in the centre of the 4½-way; then fix this lens-board 8 in. away from the back end, still measuring from the extreme length of the tongue; this is marked B in Fig. 118, p. 69. Fix a false bottom as shown at C (Fig. 118) to receive the plate and sheath when it falls from the plate chamber. It is slipped under the shelf by canting the camera, and lies there face downward till others are exposed. For the front and back two pieces will be required the outside size of the body, which should be 5$\frac{15}{16}$ in. long, 5 in. wide, and ⅜ in. thick. Proceed with the back first, because if spoilt for a back it will do for a front. Cut a groove $\frac{3}{32}$ in. wide and ⅛ in. deep all round, leaving $\frac{5}{32}$ in. of margin all round, but be careful not to cut through the corners. On trying to put this on the camera body, it will be found that part of the tongue on the sides projects both top and bottom, and prevents the back going on. These bits must be cut away, so as to allow the tongue to go into the groove all round. It should not be too tight a fit, but just so that it will hold on. To keep it in its place, a pair of quadrant hooks must be made, or bought, and screwed one on each side, and a small pin put into the edges of the back for these hooks to engage. If they are sunk in flush with the sides of camera, they will not be so likely to catch anything and unhook as they will if simply screwed on the sides.

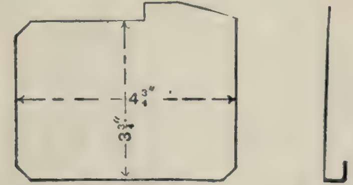


Fig. 124. Fig. 125.

Figs. 124 and 125.—Magazine Camera Sheath.

Some No. 16 B.W.G. hard brass wire should be made into two spiral springs by winding it round a ruler, broom handle, or piece of gaspipe about 1 in. diameter. Let each coil of spring be about ¼ in. from the other, and bend each end of the wire to the centre of the diameter of the spring, and form an eye to put a screw through, so as to fasten spring to back. The springs should each be about 3½ in. long. Fasten them to the back inside, 2 in. from the top and 1⅜ in. from each side. To the other end of springs fasten a piece of wood 4¼ in. long, 3 in. wide, and 5/16 in. thick. This piece follows the sheaths, and keeps the springs in their right place, so that they exert an uniform pressure on the sheaths; these are made of zinc, No. 24 B.W.G. Obtain a piece of sheet iron about No. 14 B.W.G., and file the edges up quite square all ways till the iron is $4\frac{9}{32}$ in. long and about $3\frac{1}{2}$ in. wide; the length way is the most particular. This will form a block to make the sheaths upon. Cut twelve pieces of zinc to the shape of Fig. 124, p. 73, $4\frac{3}{4}$ in. long and $3\frac{3}{4}$ in. wide in the widest part. Bend the two sides and the bottom over the iron former, so as to make a rebate for the plate, as Fig. 125. Make them so that the projecting piece on the top comes alternately right and left. These will catch alternately on the brass that projects from the top of the camera. Then, when the brass is pushed to the other end of the slot, it allows the sheath to fall forward; but the sheath behind, having the projecting piece on the other side, catches the brass, and is retained in the focus of the lens. Be very careful to fit the sheaths the upright way, so that they clear the zinc on the inside top of camera body.

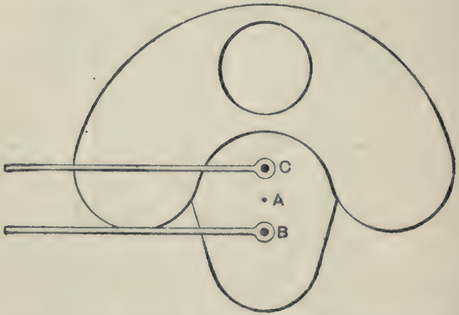


Fig. 126.—Shutter for Magazine Hand Camera.

The front is simply rebated about $\frac{1}{8}$ in. deep all round, so as to fit the front of the camera body.

Screw the lens on in its place on board B (Fig. 118). To see if the plate is in exact focus, make a spare sheath, cut a hole in the middle of it about

1½ in. or 2 in. in diameter, put in a piece of frosted glass (or a plain glass which has been obscured by dabbing with putty), put the sheath in its place in the camera, and focus on some object, screwing the lens in or out till the image is sharp. Hand-camera lenses are usually mounted so as to screw in or out for focussing.

Exposure shutters are described in Chapter IX., but it is more convenient to here describe the form of shutter best suited to the camera under consideration. The lens shutter found most useful is made, as shown in Fig. 126, from a piece of zinc. Set the compasses to a radius of 2⅛ in., and describe the arc of a circle, using A as a centre; close the compasses to ¾ in., and describe another arc. Now strike another midway between these two, and an upright line from the centre point A. Where these last two cross, strike a circle the size of the largest stop in the lens. At each end strike circles ⅛ in. larger all round than the outside size of lens, and cut out the zinc to pattern. Rivet two wires to B and C long enough to come through the side of the camera. Brass escutcheon pins make very good rivets. Bend

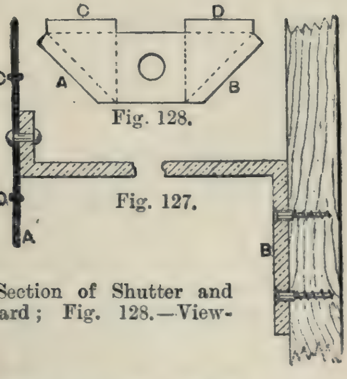


Fig. 128.

Fig. 127.

Fig. 127. — Section of Shutter and Lens Board; Fig. 128.—View-finder.

a piece of brass about ⅝ in. wide, 1⁄16 in. thick, to the shape shown in Fig. 127, p. 75, so that it will just allow the shutter to clear the lens when the brass is screwed on to the lens-board front. This figure is shown in two portions, as the distance from A to B depends on the distance the lens protrudes from the lens-board. Rivet the shutter to it through the hole A (Fig. 126, p. 74), and fix to lens-board ; bringing the wires out through the side, turn the shutter over to the right, so that the lens is covered, and cut top wire off level with the outside of the camera. Fix a little wood bracket under the shutter on the right-hand side of inside of camera to prevent the shutter going too far. Now turn the shutter back to the left, and cut the other wire and fix another bracket as before. Now by pushing the wire which projects, the shutter will open and close the lens and be always ready for use.

The view finders are made by cutting two pieces of zinc, as shown in Fig. 128. The square portion has sides 1½ in. long. The two wings are 1½ in. long on the top edge, and the sides are cut at an angle of 45°. A hole about ⅝ in. diameter should be cut in the front of finders, as shown, for the lens. The flaps, marked A and B, are bent backward to form a ledge for a piece of thin silvered glass. The flaps C and D bend forward to form a means of fastening the finder in the camera. Bend each wing backward at the dotted lines and procure two pieces of thin silvered glass, 1½ in. by 2 in., one for each finder, to fit on the ledges prepared for it. Two pieces of ground glass, 1¼ in. by 1⅜ in., will be wanted for the top of finders. In the top of camera cut a hole 1 in. long and 1⅛ in. wide, ¾ in. from the left side and ½ in. from the front edge, measuring without the front on. Cut a rebate to hold one of the ground glasses on the inside, and fix the glass in with four small brads, ground side inwards, and sunk just a little lower than the inside of the camera, to allow brads to be put in to hold it. Fix one of the zinc finders in the corner inside the camera by means of small screws through the flaps into the top of the camera, with the square portion to the front and $\frac{3}{16}$ in from the front edge of camera. This will form the finder for landscape way of plate. Now turn the camera so that the right-hand side is uppermost and proceed to cut the hole for the vertical finder. Cut this $\frac{7}{8}$ in. from the top of the camera and $\frac{3}{8}$ in. from the front edge. This hole is $1\frac{1}{8}$ in. long and 1 in. wide. Fit in the ground glass and the finder over it, as described for the first finder. Obtain two finder lenses $1\frac{5}{8}$ in. focus and about $\frac{3}{4}$ in. diameter; hold them in front of holes in finder till the image thrown on the screens is sharp; measure the distance from lens to finder, and sink the lenses into the front from the inside with a centre-bit to fit. Then cut the hole right through with a centre-bit $\frac{1}{8}$ in. smaller, thus forming a rebate to hold the lens, which may be fixed in place by a couple of small pins. Opposite the actual lens of camera cut through the front a hole the full size of outside of lens and bevel the outside edges

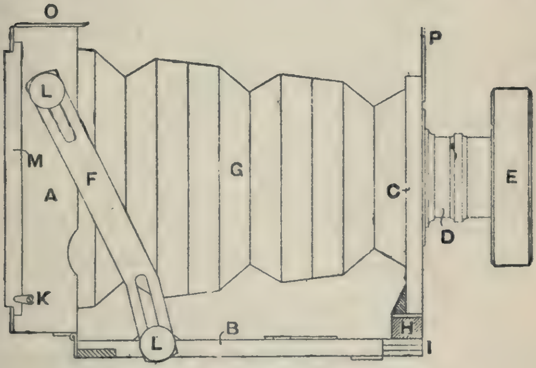


Fig. 129.—Pocket Camera Extended.

of the hole, so as not to obstruct the view of the lens. A short zinc tube should be made to extend from inside of camera front to the lens, to avoid all chance of stray light and reflections.

Stain a dead black all the interior of the camera, and all the front portion containing the lens, etc. Attach the front by means of thin screws to the body. Small zinc flaps may be made to cover the finders by soldering a piece of brass wire across the end of a piece of zinc the width of finder openings, and fastening to the top of camera by means of two bent pins. The whole of the outside may be covered with American cloth, bookbinders' cloth, morocco, or whatever the maker may fancy. A leather handle should be attached lengthways to the top of the camera, for convenience of carriage.

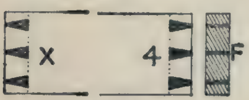


Fig. 130.

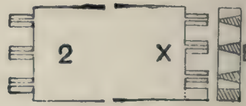


Fig. 132.

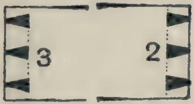


Fig. 131.

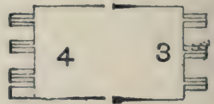


Fig. 133.

Figs. 130 to 133.—Dovetailed Parts of Camera Body.

The $\frac{1}{4}$-plate pocket camera for use as a hand or stand camera, illustrated by Fig. 129, p. 76, and now about to be described is light, strong, rigid, and compact. It is capable of extending so as to permit of using a lens having a focal length at least as long as the diagonal of the plate which is to be used. To go into the pocket it has a bellows, which must be made as thin as possible consistent with strength, but which must nevertheless be of two thicknesses of material—thin hard rolled leather outside and fine black cloth inside. The tapered form of bellows is the best where bulk is to be avoided. For photographing buildings, etc., the camera must have a swing back, and the swing back must apply to vertical as well as to horizontal pictures. There must be an arrangement for focussing with and without the focussing screen. The camera should not have loose parts.

The lens is perhaps the most important feature in any camera, and more particularly so in a hand camera, where it is generally used with as wide an aperture as possible for the sake of speed. For ¼-plate (4¼ in. by 3¼ in.) it should have a focal length of about 5½ in.; it should be what is commonly known as a rapid rectilinear, and should have an iris diaphragm. It should give perfect definition right to the edges of a ¼-plate, with an aperture equal to one-eighth of its focal length. The hood should be removable to permit of fixing the shutter directly on the lens tube and so curtailing the bulk of the shutter.

The best kind of wood for the small pocket camera is Spanish mahogany, but very plain straight-grained stuff must be selected, as strength is more important than ornamentation, and finely-figured Spanish mahogany is too brittle and too difficult to work for the present purpose. Failing this, Tobasca mahogany will do very well, but the ordinary soft bay-wood is not good enough. The thickness of the body when finished may be $\frac{3}{16}$ in., but the amateur dovetailer will probably succeed better with ¼ in., and even that is not too thick.

Begin by cutting two pieces of mahogany 5⅝ in. by 1 in. by ¼ in. and two pieces 4¾ in. by 1 in. by ¼ in. for the camera body (A, Fig. 129, p. 77). They must be cut just a trifle longer and broader at first, and the ends and edges planed up to just these sizes on the shooting-board. The ends should be planed first with a tool having but little of the iron projecting, for the wood will be apt to chip away. Set a marking-gauge to the thickness of the wood—in this case ¼ in.—and gauge a faint line all round each end on both sides, to serve as a guide in dovetailing. This gauged line is seen dotted in Figs. 130 to 133. Figs. 130 and 131 are the right and left hand ends respectively, and Figs. 132 and 133 are the top and bottom respectively. In Fig. 129, A is the camera body, B is the base-board, C the camera front, D the lens, E the instantaneous shutter, F the strut for clamping the swing back, G bellows, H block for raising front, I hard-wood feather, K brass button, L milled screws, M focussing screen, O spring catch, P rifle sight or view finder.

The breadth of one of the shorter pieces (Fig. 130) must be reduced by ⅛ in. This is to allow the dark slide to slide into the rebate; and when the camera is finished, this narrow side will be at the right-hand side when seen from behind.

The usual method of dovetailing is to cut the pins (as at Figs. 132 and 133) first, and to mark the dovetails from these with a pencil or draw-point. This plan answers well enough in wood ½ in. thick and over, but it is not so suitable for small work like this. The plan recommended is to cut the dovetails first (as at Figs. 130 and 131) with a fine dovetail saw, dividing them off first with compasses, and being careful to cut square through and just down to the gauge line. A number of pieces may be cut at once with advantage, but in making only one camera this cannot be done, as one side being ⅛ in. broader than the other the dovetails will be differently spaced.

Having cut down to the gauge mark with the dovetail saw, the small pieces marked black in Figs. 130 and 131 are cut out with a ⅛-in. chisel, cutting halfway through from each side, and being careful not to cut or bruise beyond the gauge mark. At this point of the proceedings it will be advisable to mark the pieces as they will go together, as shown in Figs.

130 to 133, bearing in mind that the markings will be on the outside when the frame is put together. In order to draw the pins which are to fit into the dovetails, procure some finely powdered chalk, and tie a little up in a scrap of muslin to make a pounce-bag. Fix the piece shown by Fig. 132, p. 78, upright in the vice, with its marked side away from the worker, and the end marked X at the top. Moisten the end wood slightly with a damp sponge, to make the chalk adhere. Lay the piece shown by Fig. 130 in a horizontal position, so that the end marked X will be flush with the top end of Fig. 132. Make a few dabs with the pounce-bag, and carefully remove the piece shown by Fig. 130, and the dovetails will be found very plainly marked. The chalk being left on, the dovetails must be very carefully and squarely cut down to the gauge line, but no further. If any of the chalk mark is cut away, the pins will not fill the dovetail; whilst if the cut does not extend quite to the chalk mark the pins will be too tight, and will either split the wood or break off when being driven home. In hardwood there is not much margin between tight and slack, but a few trials on odd pieces of which a front view is seen at L (Fig. 138, p. 85)

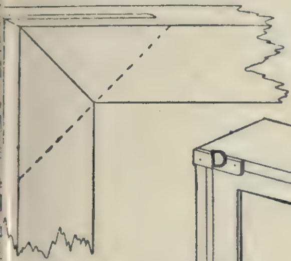
Proceed in a similar manner with the remaining corners, and cut away the wood between the pins with a small, sharp chisel, halfway through from each side, and exactly to the gauge line, as before. The dovetails may be tried together before gluing, and make sure that they fit well, taking a paring off the pins if they appear dangerously tight. In gluing up, use as light a hammer as possible, and rivet the pins a little; this will make them hold all the better. Make quite certain that the frame is perfectly square before setting it away to dry. If necessary, cautiously jamb in a diagonal piece of stick, to keep it square, but be careful in doing this not to loosen any of the joints. Wash the glue out of the corners with a hot wet sponge.

While this is hardening the bellows frame may be made. It is made of mahogany $\frac{1}{8}$ in. thick when finished, mitred at the corners, and keyed. The inside size of the camera body will be $5\frac{1}{8}$ in. by $4\frac{1}{4}$ in., which is therefore the over-all size of the bellows frame. The opening inside of the bellows frame, the "daylight" as it is generally termed, is 4 in. by 3 in., so that it must be made of stuff say $\frac{3}{4}$ in. broad, which will leave plenty of margin for fitting. It should be made $\frac{3}{16}$ in. thick at first, and only planed down to its proper thickness, $\frac{1}{8}$ in., after it is keyed, and the glue is hard; even then it has to be handled carefully. Having mitred the frame to the correct size, it is glued at the corners with strong, hot glue; a string with a running noose is passed several times round the edge, and it is put in a warm place to harden. When it is thoroughly hard, a saw-cut is run down each corner, into which is glued a stout veneer. Plane-tree veneer is generally chosen for this purpose, but any other kind of hardwood will do, if this is not at hand. Fig. 134 will make this keyed joint plain; the dotted line shows the depth of the saw-cut.

When the glue is quite hard, the frame is planed level on one side, gauged to $\frac{1}{8}$ in. thick all round, and planed down to the gauge mark. Take care in doing this not to remove more from one side than the other, or the key may be laid bare, and the benefit of it lost. The edges are planed on the shooting-board till the frame fits neatly inside the back of the camera body, fitting it the breadth way first. When properly fitted it is glued into position, just level with the narrow side, and consequently $\frac{1}{8}$ in. inside of the top and bottom edges, which form a rebate for the dark slide.

The bellows should be bought, as it is scarcely within the range of an amateur's ability to make a neat job of such a small tapered bellows; though they can be made if the instructions in Chapter II.

are followed. The bellows measure 5 in. by 4⅛ in. at back, 2¾ in. square at front, and draw out to 7 in. This draw enables an object two feet from the camera to be focussed with a lens of 5½ in. focus, and enables full advantage to be taken of the long extension. If the bellows is neatly made, and of the proper thin materials, it should not occupy more space than ½ in. when folded. Allowing ¼ in. for the camera front, ½ in. for the bellows, ⅛ in. for the bellows frame, and ⅛ in. for the rebate for the dark slide to lie in, makes the body of the camera just 1 in. broad over all. The base-board and focussing screen go outside this, and increase the bulk when folded up to 1½ in., which is no great obstruction in the average coat pocket.



ig. 134.

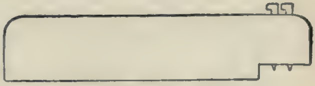


Fig. 136.

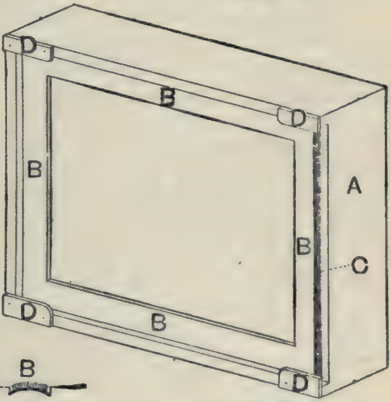


Fig. 135.

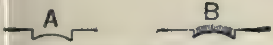


Fig. 137.

Fig. 134.—Keyed Joint; Fig. 135.—Pocket Camera Body; Fig. 136.—Grooving Tool; Fig. 137.—Section of Velvet-lined Groove.

Fig. 135 shows the position of the bellows frame in the camera body. When the frame is glued in, all superfluous glue is washed away from the outside, but a coating of thin glue round the inside will make the gluing-in of the bellows an easier matter. When this is hard, but not till then, carefully clean off the sides and edges of the body with a very sharp hand-plane, taking particular care not to chip away the corners. With straight-grained wood this will be a comparatively easy matter, the planing being done from the corner towards the centre in both directions, and the corners being kept whole and sharp. Should a little chip come away, the corners may be rounded and the fracture concealed, but they are better left square.

In Fig. 135, p. 83, A is the narrow end, B bellows frame, and D brass plates for securing the dark slide. At C (Fig. 135) is indicated a strip of velvet ribbon, which makes a light-tight joint with the dark slide. Fig. 136 shows a tool which may be made in a few minutes from a scrap of hardwood and two steel brads, and which will form a neat groove for the ribbon. A cutting of mahogany or birch, about 4 in. by 1 in. by $\frac{1}{4}$ in., is taken, and a check 1 in. long and $\frac{1}{2}$ in. deep cut at one end. The first brad is driven in $\frac{1}{8}$ in. from the end of the check, the other brad is driven in $\frac{1}{4}$ in. from the first, leaving about $\frac{1}{8}$ in. projecting. The projecting ends are then filed to form cutting points. This forms a gauge which will cut down the edges of the groove sufficiently deep for the purpose.

The groove is cleaned out with a small chisel to the shape shown in section at A (Fig. 137), about $\frac{1}{32}$ in. deep in the centre, and slightly deeper at the edges. A yard of velvet ribbon $\frac{1}{4}$ in. wide is procured. When the velvet is glued into the groove, its edges are well tucked down into the deep corners, and so saved from being torn up when putting in the dark slide. The entire back of the bellows frame may now be blackened, also the inside of the camera body, excepting the inside of the bellows frame (see pp. 48 and 49).

The bellows may now be glued into its place with good hot glue, and a weight put on it till it dries. Of course, the joints must be true to start with, and it is very important that both pieces which are to be glued should be hot, not simply warm, and the glue should be on the verge of boiling. Draughts must be avoided, as they cause the glue to congeal before the joint is properly made.

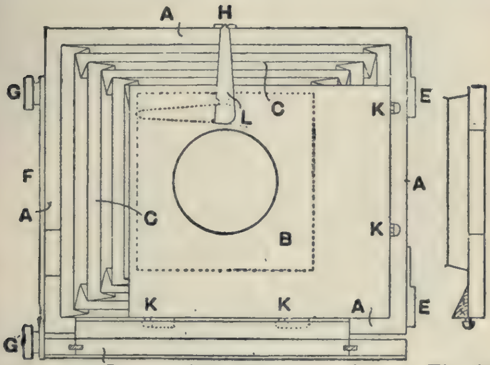


Fig. 138. Fig 139.

Figs. 138 and 139.—Elevation and Section of Camera Front.

Fig. 138 shows the camera body with front glued to bellows; the letter references are—A, edge of camera body; B, camera front; C, bellows; D, baseboard; E, pull-off hinges; F, edge of swing-back strut; G, milled screws which fix strut; H, spring catch; K, round-headed brass screws for fixing camera front to slotted plate; L, front portion of rifle sight.

The camera front, measuring 4 in. by 3½ in. by ¼ in. is now made; it is shown in elevation by Fig.

138, and in section by Fig. 139. Along two edges of it, as shown by the dotted lines in Fig. 138, are glued bevelled fillets ½ in. broad and ¼ in. thick, for the purpose of giving a broader base of support on the base-board. The shorter fillet also serves as a clamp to prevent the front from warping. The two edges with their fillets are planed square on the shooting-board, and the front is laid in position on the bellows, as in Fig. 138. Diagonal lines from the corners of the back will give the centre of the aperture which is to be cut in the front for the lens, the aperture in this case being 1⅝ in. in diameter.

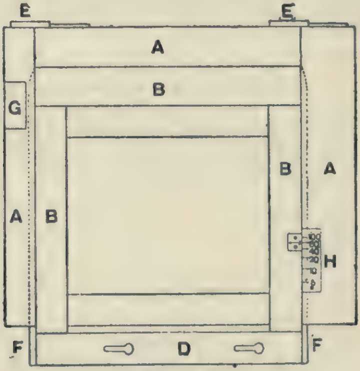


Fig. 140.

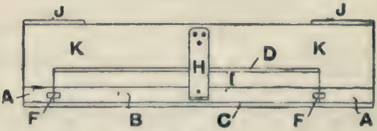


Fig. 141.

Figs. 140 and 141.—Plan and End Section of Baseboard.

The aperture being cut with a fret or keyhole saw, the front may be glued to the bellows. The principal thing to be observed in this is that the bellows should fall naturally into the corner of the body, as shown in Fig. 138. Lay aside the body of the camera, and proceed with the base-board, shown in plan and end elevation by Figs. 140 and 141, from which the exact dimensions can be got, as they are drawn to scale. The part which is hinged to the camera consists of three pieces, A A A, $\frac{1}{4}$ in. thick when finished, which are joined by means of half checking and gluing; see that the two limbs of the frame are quite out of twist before and after gluing up. American spring clothes-pins or wooden paper-clips are very handy for gripping a joint like this when examining for twist and when gluing. But,

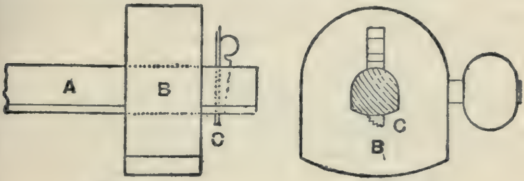


Fig. 142. **Fig. 143.**

Figs. 142 and 143.—Grooving Gauge.

before gluing, make a groove along the inside edges of the two side pieces for the extending piece to slide in, cutting the groove exactly in the centre of the thickness of the wood, $\frac{1}{8}$ in. deep and $\frac{3}{32}$ in. wide. It is carried quite from end to end, but is stopped where the half check begins, as shown by the dotted lines in Fig. 140. The best way of cutting this and all the other grooves and checks required in camera work is undoubtedly by means of a small circular saw furnished with a raising and lowering table. The possessor of a turning lathe can easily rig up a 3-in. or 4-in. circular saw on a $\frac{1}{2}$-in. spindle between centres, with a little table to fix into the same socket as the T-rest, and will find it well worth while to do so; but the following alternative plan, with care, will serve the purpose almost as well. A joiner's ordinary cutting gauge, such as is illustrated by Figs. 142 and 143, p. 87, is fitted with a piece broken from the blade of a keyhole saw, instead of the cutter supplied with it. The end of the blade is filed round and teeth filed on it, as shown in the end view (Fig. 143), and the teeth are set so as to cut a groove of the necessary width. The saw is fixed into the stem of the gauge with a small wedge, and is left projecting $\frac{1}{8}$ in. If the gauge is held firmly and squarely to its work, it will cut a clean square groove which will suit the purpose very well. In Figs. 142 and 143 A is the stem, B the sliding block, and C the groover.

In Fig. 140, p. 86, which is a plan of base-board, A denotes part hinged to camera body; B, sliding part which carries camera front; D, brass strip with slotted holes for fixing front; E, pull-off-hinges; F, feather glued in B, and sliding in groove in A; G, piece glued on to increase thickness of A for receiving tapered nut; H, focussing scale on base-board.

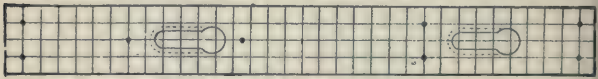


Fig. 144.—Slotted Plate for Fastening Camera Front.

In Fig. 141, which is an end elevation of base-board and top view of camera when folded up (the milled screws and strut being omitted), A is the hinged part; B, sliding part; C, brass strip connecting free ends of hinged frame, A; D, slotted brass plate for fixing camera front; F, hardwood feather; H, spring catch keeping camera closed, and forming back portion of rifle sight; I, bar glued to sliding frame for raising front; J, brass plates for securing dark slide; K, camera body.

When the grooves are cut, the frame may be glued up and a spring clip put upon each corner till it sets. Particular care must be observed to keep this frame square, and also to keep its two sides exactly parallel, otherwise the frame which is to slide in it cannot be made a good fit. This sliding frame is the next operation; it is made just the same thickness as the other, the side pieces are ½ in. broad, and the front and back pieces ⅝ in. It is half-checked also, and glued at the corners. It should be made ⅛ in. larger each way at first to allow for fitting, and great care exercised to keep it fair and square. When it is quite hard, the edges are planed on the shooting-board till it will just slide inside the other frame. Then a groove is cut along each side with the grooving gauge, in this case the groove being taken quite out to the end. A feather is fitted and glued into this groove, and when dry is eased a little so as to slide in the grooves in the base-board.

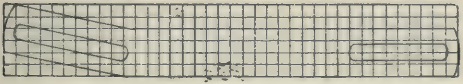


Fig. 145.—Slotted Strut for Swing Back.

Rosewood makes a very good feather for this purpose, being strong and of a greasy nature, but plane-tree or mahogany will do very well if the other is not convenient. The sliding frame and base-board are now planed level on both sides, with the frame in position, and the whole glass-papered. Fig. 140, p. 86, shows which way the checks ought to lie when the frame is in position. A piece is glued on to the front bar, as shown at I (Fig. 141), to raise the camera front to such a position that the lens will be opposite the centre of the plate, and if the checks are arranged properly this piece will materially strengthen the sliding frame; the piece is 4 in. long, ⅝ in. broad, and ¼ in. thick, and to it the slotted brass plate, D, is screwed.

The plate marked D (Figs. 140 and 141) is cut from No. 16 sheet-brass about $\frac{1}{16}$ in. thick. It is shown separately by Fig. 144, p. 88, lined off into squares representing $\frac{1}{8}$ in. each, so that the position and size of the slotted holes can be easily copied; it may be screwed on temporarily meantime. The strip marked C (Fig. 141) is cut from brass of the same thickness, and is $\frac{1}{2}$ in. broad; it has three countersunk holes at one end and two at the other, for $\frac{1}{4}$-in. No. 2 brass screws.

While working in brass the side strut may be cut out also; this is shown by Fig. 145, p. 89, the squares again representing $\frac{1}{8}$ in. each. Cut a piece of sheet-brass, No. 20 gauge, and hammer it well on a smooth iron or steel block to stiffen it; correct the shape with a file. It will be as well to make stiff paper templates of this and the other slotted plate, cutting out the slots with a sharp penknife on a waste piece of glass. Drill a small hole at one end of each marked out slot, and cut out the slots in the brass with a fine fret-saw, finishing with a ward file to fit the screws which are to work in them.

The base-board is hinged to the camera by means of pull-off hinges, of which one and a half pairs will be required. The base-board must now be fitted to the camera body so as to lie flush all round; the edges may be planed on the shooting-board, being careful when planing the end wood not to break away the corners. A recess is cut out of the top of the camera body to receive the raised piece on the base-board; this recess is seen in Fig. 141, p. 86, which shows the base-board folded up and kept closed by means of a spring catch, H. The spring catch is simply a piece of No. 24 brass $1\frac{1}{4}$ in. by $\frac{5}{16}$ in., hammered to give it a spring, and fixed at one end to the centre of the camera body with three $\frac{1}{4}$-in. No. 1 brass screws. The other end is slightly turned up, and has a $\frac{1}{16}$-in. hole about $\frac{1}{8}$ in. from the end. Into this hole fits a small brass pin, which is screwed into the front of the base-board. Raising the end of the spring releases the catch, and it catches automatically on shutting up the camera. The putting on of the hinges requires a little planning.

If the camera is required to have a swing back for horizontal pictures only, one pair of ordinary brass-edge hinges about 1¼ in. long only need to be put on; but for a double swing back, which is more desirable, the pull-off hinges already mentioned are necessary. In the latter case pull out the sliding frame of the base-board so that the raised bar will not come in contact with the camera body when clamped together, as illustrated by Fig. 146, which shows the back edge of the base-board and the bottom end of the camera. It will be found on pulling one of the hinges apart that the pin remains fixed in one half; this is the half which goes on the camera body, the blank half going on the base-board. When one pair of hinges has been screwed on in this position, the body is slid off to the left and again clamped to the base-board, but this time as shown by Fig. 147. The back edge of the base-board is seen as before, but this time in connection with the bottom side of the camera body. The proper halves

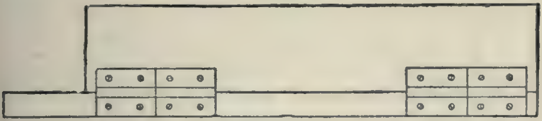


Fig. 146.

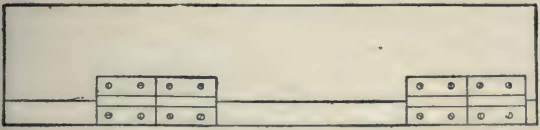


Fig. 147.

Figs. 146 and 147.—Fitting Pull-off Hinges.

of the remaining pair of hinges are taken, the pins slipped into the blanks on the base-board, and screwed to the body. In screwing on camera brass-work for the first time the screws must not be put in too tightly, as the brass-work will all require to come off to allow the wood to be polished and the brass-work to be lacquered.

The milled head screws for clamping the swing-back strut may be got from almost any dealer in photographic materials; they are ½ in. diameter at the milled head. Two screws will be required, and three tapered nuts, as shown at Fig. 148. Having filed up the slotted strut to pattern (Fig. 145, p. 89), lay it on the right-hand side of the camera in the position which it will occupy when the camera is finished and folded up, as shown at Fig. 149, in which are indicated the positions for screwing the tapered nuts at the inside ends of the slots. The hole for the tapered nut is bored with a ¼-in. centre-bit, and the nut screwed in with a screwdriver, a little glue being first put into the hole. If it is not screwed quite flush, it must be made so by filing. As the base-board is too thin to allow the nut to be sunk into its edge, a little piece of wood, ½ in. wide, is glued on, as shown at G (Fig. 140, p. 86), increasing its thickness at that point to $\frac{7}{16}$ in. When the nut has been screwed in, this extra piece is rounded off with a chisel, as shown, and a corresponding hollow is cut in the edge of the body to allow the base-board to fold up (see Fig. 129, p. 77).

If the nuts are rightly placed, the struts should lie in the position shown at Fig. 150 when the camera is folded up; and on opening out the camera it should just allow the back to come square with the base-board, as in Fig. 129, p. 77. The remaining tapered nut is screwed into the side of the body as shown by Fig. 147, in such a position that the strut allows the back to come square as before, when the camera is arranged for vertical pictures. In so arranging the camera, where the swing back is not required and the camera is to be used in the hand, it may simply be turned bodily on its side—or on its end, rather. If the swing back be needed, or if the camera is to be used on a stand, it is necessary to undo the upper milled screw, reverse body and front, and put the screw into the other nut provided for it. The trouble of undoing the screw might be obviated by having one end of the slot in the strut open, but this plan has serious disadvantages, and is not recommended. The camera front has now to be fitted to the raised piece on the sliding part of the base-board by means of round-headed brass screws and the slotted brass plate (Fig. 144, p. 88). This plate must be carefully filed up as shown in the drawing, making the slots to fit the stem of the screw, and the holes at the ends of the slots to clear the screw head. Four ½-in. No. 5 brass round-headed screws will be needed, and in order to find the proper positions for these on the edges of the front first screw down the brass plate on the raised piece of the frame; then, with the camera back set in position for horizontal pictures and clamped, extend the front, and when the centre of the lens opening is

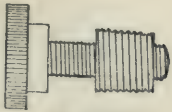


Fig. 148.

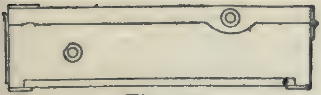


Fig. 149.

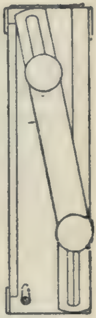


Fig. 150.

Fig. 148.—Milled-head Screw and Nut; Fig. 149.—Side View of Camera and Base-board; Fig. 150.—Folded-up Camera and Body.

opposite the centre of the back make a mark on the right-hand end of the plate at the end of the front. Proceed in a similar manner with the camera set for vertical pictures, but this time the mark will be at the left-hand end of the plate. Remove the plate, place it in its proper position on the under side of the front, and mark the centre of the screw holes; do the same on the end of the front, and put in the screws, leaving them projecting just sufficiently to allow them to slide along the slots without allowing any play to the front.

Cut away wood of the raised piece as shown by the dotted lines (Fig. 144, p. 88), to allow the screw heads an entrance; and finally screw down the brass with $\frac{3}{8}$-in. No. 2 brass screws, and file flat with a dead smooth file; if the brass is not flat, the camera front will not be firm. On attempting to replace the front into the body it will be found that the projecting screw heads prevent its getting in. They must be let into the edge of the body by means of a small gouge till the front will lie level with the edges; the screws are shown in position by Fig. 138, p. 85. A section of the front in position is given by Fig. 139, p. 85, showing the screw heads projecting. In putting in these screws take great care to prevent splitting the edges of the front, as it is only $\frac{1}{2}$ in. thick in all, and the screw comes right into the joint between the clamp and front, so that the holes for the screws must be carefully bored. It is a good plan, in boring holes and putting screws into thin wood, to grip the wood in a handscrew just at the place; it allows the worker more freedom, and in a great measure prevents splitting.

The construction of the camera is now complete, though, of course, the dark slides still remain to be made (see pp. 121 to 129). The camera brass-work may now be removed, and the wood coated with raw linseed oil in which has been steeped alkanet root; this gives a rich colour and prepares it for polishing.

The focussing screen should be made at the same time as the dark slides, so that it will register with them. Its framing is rectangular in section, with a square rebate run on one edge. It is mitred at the corners and keyed, in the same manner as the bellows frame (see p. 82), and the size of the opening must be 4 in. by 3 in., which allows a 4¼-in. by 3¼-in. focussing glass to have a rest of ⅛ in. all round in the check. The glass must be acid-etched, as the granulations in ordinary ground glass are much too coarse to allow of fine details being focussed sharply. The glass is etched easily with dilute fluoric acid. Two small brass plates, one at each end, keep the glass in position.

The camera and dark slides should be French polished, every care being taken not to fill up the checks and grooves with polish or filling materials. A simple but satisfactory method of polishing in which filling is not used is to coat the wood well with linseed-oil in which has been steeped bruised alkanet root. Next day well rub in white polish—more properly, colourless polish—and polish off with as little shellac on the surface of the wood as possible. The pores are thus well filled, but there is no thick body of polish to scratch, consequently the polish stands handling longer. The shutters of the dark slides are polished separately from the frames; there is thus no chance of a shutter sticking in the groove, as is certain to happen if polished in position.

The brass-work must be finished off with a dead-smooth file, followed by fine emery-paper on a cork, and then lacquered, gold coloured lacquer being used. The brass, having been polished with emery, must not be touched with a finger before lacquering, or a mark will be left. Heat the brass by any convenient means—say, an iron plate over a gas heater—till it is rather hot to touch with the hand. A flat camel-hair brush about ½ in. broad, is dipped in the lacquer, and rapidly brushed along the article, which may be held in a pair of pliers. The lacquer should dry off instantly, but without burning; and several successive coats may be laid on till a rich colour is got, when the article is returned to the hot plate for a little while and then allowed to cool before being touched by hand.

The view-finder most convenient for this type of camera is a kind of rifle-sight arrangement. The back sight is formed by a V-shaped notch filed in the spring catch, which keeps the camera closed when folded up, as shown at H (Fig. 138, p. 85). The front sight is a narrow strip of thin sheet brass pivoted on a screw in the centre of the camera front, of which a front view is seen at L (Fig. 138, p. 85 and a side view at P (Fig. 129, p. 77). It can be folded down when not in use, and a small brass pin stops it when it is raised to the vertical position. The two sights are so arranged that when the point of the fore sight just fills the notch of the back sight the object which is directly in line with them is exactly in the centre of the plate. With this sight it is much easier to follow a moving object and catch it fairly in the centre of the plate than with the ordinary form of view-finder with its lens, reflector, and ground glass, as the operator's eye is following the object itself, and not a reflected image of it moving on quite a different plane. Then, the camera being held up in front, the operator is much less likely to hold it off the level than when looking down on it. Its simplicity and cheapness also commend it.

The focussing scale shown at H (Fig. 140, p. 86) is formed by screwing a small, thin brass plate, having an arrow engraved on it, to the sliding frame of the base-board. A longer plate of the same thickness is screwed on to the hinged part of the baseboard alongside of the first; objects at various known distances are then sharply focussed, and the distances engraved on the plate opposite the arrow.

CHAPTER V.

FERROTYPE CAMERAS.

Ferrotype photography has been superseded, to a great extent, by more modern processes, but it is still practised, and instructions on how to make special cameras for the work may be welcome. Beyond a few minor details there is no reason why the ordinary camera should not be used for ferrotype photography. An ordinary half or quarter-plate camera answers very well, though it may be an advantage to have a repeating back and a studio slide, with a groove in the bottom for drippings and wires for plate to rest on, or it will be necessary to give the other slide a coating inside of paraffin wax. Those who consistently practise ferrotypy are generally provided with an old wet-plate box camera and a French portrait-lens. As ferrotypes are slower than gelatine plates a portrait-lens is often a necessity, whilst the box camera can be freed from dust more readily. A suitable box camera may consist simply of two boxes fitting one in the other (see

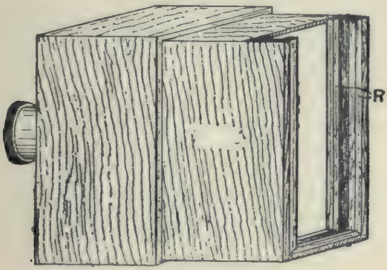


Fig. 151.—Ferrotype Camera.

Fig. 151). The outer box has in the top a slot an inch or two long, for a thumbscrew to clamp together the inner and outer boxes. Rails R, at back, take the focussing screen and slide, and the fine focussing is done with the rack and pinion on lens. As ferrotypy is a positive process, each picture has to be separately exposed. Where only two or so pictures are required, this may be done with the repeating-back, but a battery of lenses for taking a number of pictures in one exposure is the general plan.

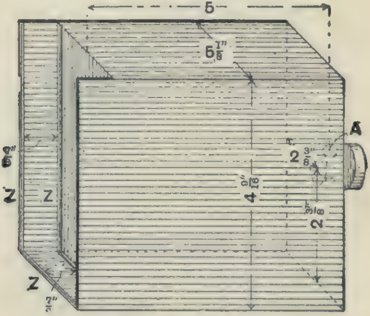
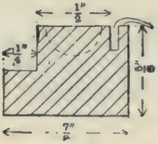


Fig. 152.—Ferrotype Camera.

The following are instructions on making a cheap camera for taking portraits on ferrotype plates $3\frac{1}{4}$ in. by $2\frac{3}{4}$ in. A portrait lens of 5-in. focus should be procured and the camera made to suit it. The lens will probably be fitted with an outer jacket (which screws into a flange for attaching to camera front), in which the lens is moved backwards and forwards by a rack and pinion for focussing (A, Fig. 152). To make the dark slide, groove and rebate three pieces of the form and size shown in Figs. 153 and 154, and mitre the ends. In one piece gouge out a part of the middle, shown by the dotted semicircle in Fig. 153; stop about $\frac{1}{8}$ in. from each end. This forms a trough to hold the drippings from the plates, and it may be covered with metal. In the top of the two sides at X (Fig. 155) is a wide slot that receives a tongue B in the top rail. This top rail is shown by dotted lines in Fig. 157, p. 100, and recessed at V to take a narrow strip of velvet. Now cut the pieces A B C D (Fig. 155), and glue and tongue together A D C; attach B to the rest with a strip of opaque



Figs. 153.—Section of Dark Slide Framing.

Fig. 156. Place the two mitred corners together in the bench, and, having made a saw-cut across, insert and glue in a strip of veneer (see p. 82). Fix the top bar with the front tongue cut away as in

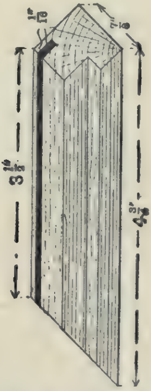


Fig. 154.—Piece of Dark Slide Framing.

cloth, making a board 4½ in. by 3¾ in. having an ⅛-in. rebate on three sides. Fit into the grooves of the framework and glue on stops at the back to prevent complete withdrawal. A strip S is glued to the sides to form a shoulder which shuts down on the top of the camera and helps to exclude light. Fix silver wires, bent as in Fig. 158, 2¾ in. apart, two in each side, to take the plate horizontally and vertically. These project into the slide ⅛ in. Glue in the guiding strips for the slides Z Z (Fig. 152, p. 98). Fix in the slide against the wires a piece of ground glass, rough side inwards; insert the slide in the camera and focus. Remove the slide gently and insert a framework made by joining four pieces 4¾ in. by ⅞ in. by ⅝ in.; adjust the ground glass so that it will register correctly with the slide, and fix. Cut a board 4¼ in. by 4¼ in., and attach to its inner side a flat spring to hold the plate in position. Hinge this board at the top and put a button at the bottom to fasten it, and the apparatus is complete.

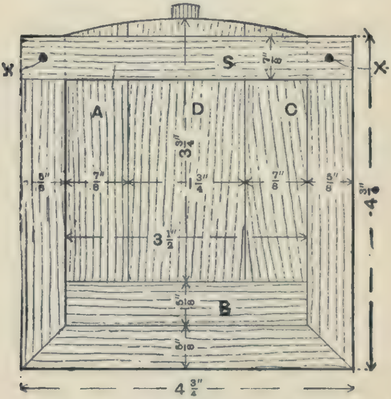


Fig. 155.—Dark Slide and Rails.

The so-called automatic camera for dry ferrotype plates consists practically of a magazine camera sliding upon rails, under the centre of which is a rubber-lined tank used for developing, and connected with it are three rubber balls, each containing one of the three necessary solutions capable of being forced up into the tank in turn by pressing the ball, whilst turning a tap prevents the liquid from running back. The whole is supported upon a tripod having a sort of cupboard at top for bottles, etc. The construction of the camera enabling the plates to fall one at a time is shown in Fig. 159; A is

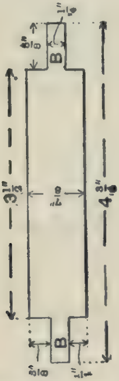


Fig. 156.—Top Rail.

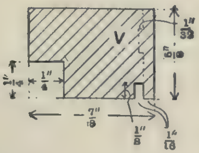


Fig. 157.—Top Rail Section.

the lens with rack and pinion; B, to which may be fitted a simple pull-up-and-down shutter; C is the focussing screen, guided forward into position by the nut D; E E are side rails, guiding the fall of the plate and holding it in an upright position; F and G are open chambers, the former containing the magazine H for holding the plates; I and J are doors. Insert the magazine H through the door I, and bolt the lid or bottom to the sides at K. Open the door J and push the screen C into place, focus with lens, pull back the screen, close the door, and then turn the thumbscrew, revolving the pinion L, which, moving the magazine forward, brings the first plate over the opening in the floor of the chamber. Now pull out the catch M and the plate will fall into position between the rails E E in the chamber below, for in winding the magazine forward the lid will have

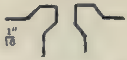


Fig. 158.—Plate Wires.

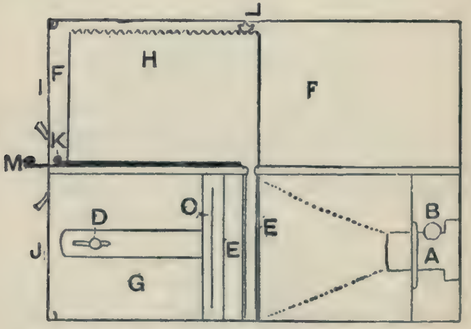


Fig. 159.—Automatic Ferrotype Camera.

been left bolted behind, and nothing remains to stop the free passage of the plate. Return the catch and the camera is ready for exposure. The exposed plate falls into the developing box below by means of two similar catches, one in the camera and another over the tank. This developing-box can be used with ordinary as well as ferrotype plates; by taking it off, the camera may be used as a hand camera.

CHAPTER VI.

STEREOSCOPIC CAMERAS.

STEREOSCOPIC effect or the appearance of relief in photographs depends in the combining in one in the stereoscope of two representations of the same scene taken from slightly different points of view. Stereoscopic photographs, therefore, are best obtained with a camera having a pair of lenses fitted side by side. These lenses should be accurately matched as regards focus, ratio, aperture, colour, etc., and should be $2\frac{3}{4}$ in. or 3 in. apart, which is about the distance between the eyes. With this camera two pictures will be taken at the same time. Paired lenses are sold for the purpose. A method of taking stereoscopic photographs with one lens only (a half-plate camera being used) is to employ a couple of mirrors set at such an angle as to have two points of sight. These mirrors are in front of the lens and reflect the image through the lens on to the plate, the advantage being that no transposition of the prints is necessary. This instrument, known as the "stereoscopic transmitter," is the invention of Mr. Theodore Brown, of Salisbury.

Still objects, and ordinary landscapes in which there are no moving figures, can be taken with only one lens if a square bellows camera is fitted with a sliding front. Fig. 160 explains the construction of a sliding front. The first exposure is made, and A is then pushed along until the mark B points to the mark C. The opening in the front board of the camera is shown by dotted lines. The distance between the two points may be varied according to the distance of the principal object. The farther the principal object is from the camera the greater must be the separation between the two points. Sometimes it is possible to obtain stereoscopic photographs by moving the object, as, for example, a vase of flowers. In this case the camera and lens are stationary and an ordinary quarter-plate camera can be used. Such a camera may also be used if it is fitted with a board as wide as the base from back to front and about double the length of the original base. Two parallel slots are made in this extra baseboard, and thumbscrews pass through these into the original baseboard. The camera may thus be slid from one position to the other and clamped.

The camera about to be described may be used as a hand or stand camera for taking ordinary half-plate photographs or for stereoscopic work, for the latter of which purposes it is particularly suited. Either one or two lenses may be employed, but except under favourable circumstances of light and subject, one lens alone is not of much practical use. Mahogany $\frac{3}{8}$ in. will be suitable for the camera body. Make the baseboard (Fig. 161) by joining up three pieces, A, B, and C, crossing the grain, and work out the grooves D. These are for the pinion and racks. Next join up the extension frame (Fig. 162), which consists of two pieces $5\frac{3}{4}$ in. by $1\frac{1}{8}$ in., one piece E $7\frac{1}{8}$ in. by $1\frac{1}{4}$ in., and one F $7\frac{1}{8}$ in. by $3\frac{1}{8}$ in., tongued together. The two rails are of rectangular section ($\frac{1}{4}$ in. by $\frac{1}{2}$ in.), with a rebate on one edge. Screw and glue them on,

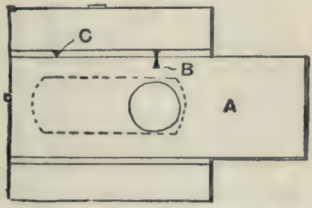


Fig. 160.—Sliding Camera Front.

running the length of the base at G (Fig. 160), with the rebate inwards to engage with the tongue H (Fig. 162) of the extension frame. Fit the parts together and cut across the line at I (Figs. 161 and 162). Attach rule hinges at J (Figs. 161 and 168) for the base, and flat hinges at K (Fig. 162) to the extension frame. The sliding body (Fig. 163) is a mere frame 8 in. square, but through it pass the clamping rods Z, close to frame, which, biting against L (Fig. 162) at X (Fig 163) hold the frame and its attachments at any distance from the front.

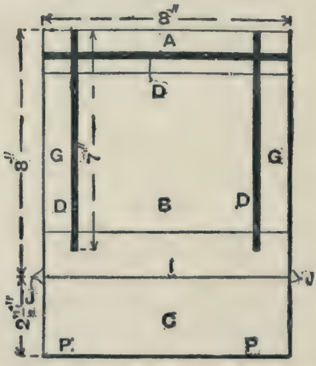


Fig. 161.—Stereoscopic Camera Baseboard.

Now in ⅜-in. stuff make a frame M (Fig. 164) 8 in. square, with a centre opening 5½ in. square, and to it attach the front end of the bellows. This bellows may be purchased ready-made, or the directions given in Chapter II. may be followed, but square bellows are essential. The frame is fixed at P (Fig. 161), and built up to the required height with a strip of wood. It is fastened by means of screws put through from the under side of the baseboard, and by corner pieces as shown in Fig. 168. At each side of M (Fig. 164) are fixed rails N, 8⅜ in. long, to take the rising front R, and across this are run two rails for the lens board. A brass plate Q 2½ in. long, and a screw fitting a nut in N, which may be made to bite against Q when screwed down, and which will hold it at different elevations, provide the rising front adjustment. The back frame (Fig. 165), 8 in. square, may then be joined up, and is similar to Fig. 163, except that it contains an inner frame, which must

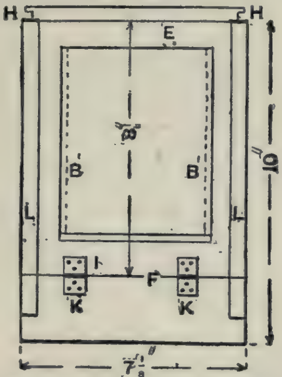


Fig. 162.—Stereoscopic Camera Extension Frame.

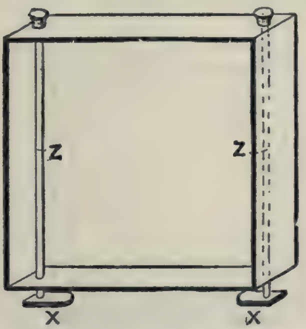
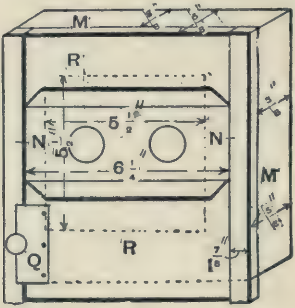


Fig. 163.—Sliding Body of Stereoscopic Camera.

be flush with the side nearer the lens, but ⅛ in. back from the other side; to the former side is glued the back of the bellows, and the side which is recessed



Figs. 164.—Front-board Frame.

is covered with black velvet. Screw two angle plates at S, and attach the whole to the sliding body by means of four slotted plates T (Fig. 168) 2¼ in. long. Thumb-screws U through the slots allow the

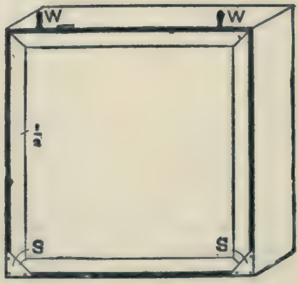


Fig. 165.—Back Frame of Stereoscopic Camera.

back to be clamped in any position. This provides the swing-back movement. Now make another frame (Fig. 166) to fit the recess, with an opening

6¾ in. by 4½ in., and across it at V screw rails, sections of which are shown in Fig. 167. The focussing frame scarcely needs description, after the construction of similar frames has already been described in former chapters; it fits between the rails V (Fig. 166), and carries a sheet of ground glass 6½ in. by 4¾ in., rough side inwards. Small turn-buttons at W (Fig. 165) serve to hold in position the reversing frame. Brass clamps as in Fig. 168 should be at-

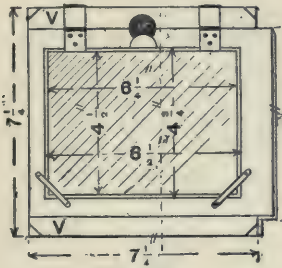


Fig. 166.

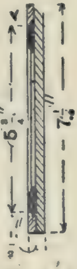


Fig. 167.

Figs. 166, 167.—Reversing Frame.

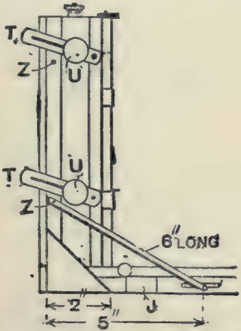


Fig. 168.—Stereoscopic Camera with Frames closed.

tached to the edge of the baseboard, and screws Z Z to take the clamps. Remove the extension frame and screw on the racks B (Fig. 162), and fix in a pinion, not shown in the illustration, of the usual shape, having a brass milled head.

For the collapsible division, which next must be fitted, a strip of black twill must be cut 6 in. by 18 in. ; run a hem along either side of the longer edges, and through this thread some flat elastic. Pleat the twill and stitch it to the elastic at distances of about ¼ in. The elastic band must be not more than the focus of the lens, say 8 in., in length. A loop is left at each end for attachment to the camera front and to the back bellows frame, and the division accommodates itself to any extension of the camera. When the camera is required for ordinary work, the division is easily removed.

CHAPTER VII.

ENLARGING CAMERAS.

In this chapter it is proposed to describe the method of making a cheap enlarging camera which, when not in use, can be packed into a small space. If made to the dimensions given below it will allow of enlargements up to whole plate, and will pack up into a space of 10½ in. by 9 in. by 4½ in. By modifying the dimensions given, the directions will apply to the construction of a camera of any ordinary size.

Fig. 169, p. 113, is a sketch of the camera with bellows and front removed. The base consists of three sections, A, B, and C. The back section A measures 9 in. by 4¼ in. To this is fixed the back of the camera J, which is made as follows: From a piece of good stout cardboard, or preferably, millboard, measuring 10½ in. by 9 in. is cut a square measuring a little more than 8½ in. by 6½ in., its sides being parallel to the edges of the cardboard, the remains of which form a frame all in one piece (see J, Fig. 170, p. 113). Now cut three pieces of wood (H, Figs. 169 and 170) ½ in. square, two 10½ in. long and the third 8 in. long. These are glued to one face of the frame, which is then firmly fixed to the baseboard A by gluing and by two small screws. The two parts must be fixed exactly at right angles to each other, and the back may be rendered firmer by means of supports, D D (Fig. 169). Before fixing the back in position it is advisable to fasten on the bellows, which will be described later. Fig. 170 is an elevation of the back, Fig. 171 showing the camera packed up.

The middle part of the base B measures 8½ in. by 8 in. Along the two longer edges of one face are glued two strips of wood about ½ in. broad and just a shade thicker than the wood which is to be used for the part of the base marked C. Over these are glued strips (E, E, Fig. 169) about 1 in. broad, between which and the base-piece B slides the piece C. B is hinged to A either by two small hinges or by a strip of brown paper glued on; over the paper is a rather broader strip of black calico or linenette

The front part of the base C is 8 in. long and about 7 in. wide. It slides over B, and should be just wide enough to slide in with a little friction. Across the front end and underneath is fastened a piece P 2 in. broad, cut with the grain of the wood at right angles to the grain in C, thus tending to prevent C from warping; it should project about ⅛ in. in front of C. At the front end of the base are two upright pieces F, F, firmly attached at right angles to it, and grooved on the inner faces to receive the camera front. Their height should be 4 in., but in breadth and thickness they may be made according to taste.

Before attaching the bellows the base-board should be completely finished. A flat piece of brass G should be fixed to A by a small screw near the front edge, but left so as to turn. When the camera is to be used this is turned so as to project over B, which is thus kept in the same plane as A.

The bellows may be very well made from a piece of brown paper, over one side of which has been pasted a suitable-sized piece of black linenette, or any thin soft material (see p. 46). Before folding, the bellows should measure at the large end about 9¾ in. by 7¾ in., tapering to about 5 in. by 4 in. at the small end; they should be 25 in. to 27 in. long. The folds should be made a very little over ½ in. deep, and it will then be found that the bellows will be a little over 8½ in. by 6½ in. at the back end and 4 in. by 3 in. at the front end. If preferred, an oblong bellows can be used, but it will not pack so easily and will require the camera front to be very little less than the back. Details of construction need not here be described, as full information, together with illustrations, on bellows making, is given in Chapter II. The bellows, when made, are blacked inside as described on p. 48.

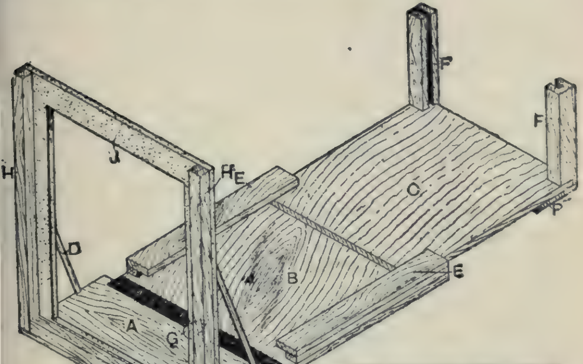


Fig. 169.

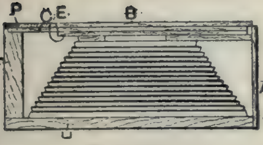


Fig. 171.

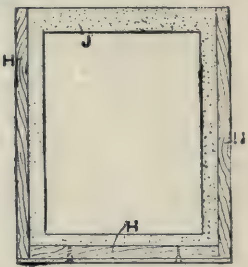


Fig. 170.

Fig. 169.—Enlarging Camera with Bellows and Front removed; Fig. 170.—Back of Camera; Fig. 171.—Camera packed up.

The front of the camera, which is made to slide in between the uprights F F, should have a height of nearly 8 in. If made of wood, it is better to cut a rebate on each edge so as to leave a tongue-like piece down each side, as shown in Fig. 172, p. 115. The tongue should be a shade narrower than the grooves in which it slides. If made of cardboard, two pieces should be glued together, one wide enough to slide in the grooves, the other being as wide as the space between the uprights themselves. The hole in front for the lens should be made so that its centre is directly opposite the centre of the opening of the back, that is about 5¼ in. above the base.

The front is glued to the bellows so that the hole is exactly in the middle of the small end. The attachment is best made light-tight by previously gluing inside the end of the bellows a piece of cardboard which just fits, and has a hole in the centre a little larger than that in the front. When dry, this can be glued on the front. The bellows must then have its large end glued to the camera back.

This completes the camera itself with the exception of one or two small details. To use the camera the base is folded down and the catch G, Fig. 169, turned to fix B in position. The front is now slid into position between the uprights and rough focussing done by sliding C in or out. It will probably be found that friction is sufficient to keep C fixed ; but if not, a row of small holes can be made along B and a hole through C so as to pass over these holes as C is moved. By pushing a small brass pin through the hole in C, and the one beneath it, the sliding piece can be fixed. Fine adjustment must be made with the ordinary camera, used in conjunction with the enlarging apparatus.

When not in use, C is pushed back over B as far as it will go, the catch G turned, and B brought up so as to be parallel with the back. When this is the case, the upright pieces F F will touch the back at their ends, where they can be held by small hooks fixed in the back, and catching in eyes fixed near the upper ends of the upright pieces. The camera then is packed away to occupy little space.

To complete the apparatus, a focussing screen and some form of dark slide are required. Perhaps the simplest form of slide which can be used either for glass or paper is made as follows: Cut a piece of wood to form the back 10 in. by 8 in. so as just to fit the camera back. In the middle of this a short piece of watch-spring is fixed by one end. Glue down the sides, and along the bottom of this back (B, Fig. 74) strips of wood about $\frac{5}{8}$ in. broad, and of such a thickness as, together with the thickness of the back, will make up $\frac{1}{2}$ in. These pieces are grooved down the inner faces near the front for the shutter (S, Fig. 174) to slide in. Figs. 173 and 174 are elevation and section respectively of the slide, and the latter figure will make this point clear. Across the top of the slide must be glued a strip of wood, H, $\frac{3}{4}$ in. broad and just thick enough to be flush with the back of the grooves in the side pieces. In the middle of this must be fixed a small catch to hold the plate when in the slide. The catch must be sunk so as not to be above the level of the wood, and must be able to be turned. To keep the plate in posttion at the bottom, two wires about 1 in. long (pins with the heads broken off will do) are driven into the wood across the angles just below the grooves. The shutter S should be tongued so as to slide in the grooves.

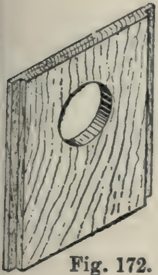


Fig. 172.

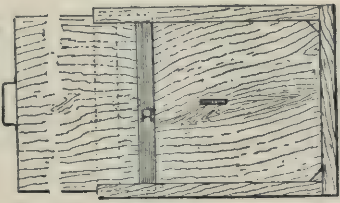


Fig. 173.

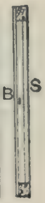


Fig 174.

Fig. 172.—Camera Front; Figs, 173 and 174.—Dark Slide.

Should it be so desired, the shutter may be cut across and hinged by means of a light-tight hinge of cloth or other material at ¾ in. from the bottom. When enlarging on paper, this can be fastened to a piece of thin wood 8½ in. by 6½ in. by means of small pins, and then placed in the slide just as a glass plate. The slide is held in position by small pins in the camera back.

A focussing screen for the enlarging camera is made by fixing a piece of finely-ground glass in a frame of wood or cardboard, and fixing down the sides of the frame in front strips of wood of such a thickness that, when placed in the back of the camera, the ground surface of the glass occupies exactly the same position as the film of the plate (or the paper) when the dark slide is in position. The frame may be hinged at the top to the camera back, so that it may be laid back over the camera when the dark slide is to be put into the required position.

CHAPTER VIII.

DARK SLIDES.

PRACTICAL experience has shown that the dark slide gives more trouble proportionately than any other part of the camera. It is imperative that it is strongly, accurately, and neatly put together. There are three forms of double dark slides, namely, the book, the solid, and the studio slide. The first-named is most generally used by amateurs.

The framework of the book dark slide (Fig. 175) is formed of four pieces of double grooving, as shown by Fig. 176. This grooving costs about 8d. a foot in mahogany, ready mitred in any required lengths. The middle rebate measures $6\frac{1}{2}$ in. by $4\frac{3}{4}$ in. full, and the front or sight opening $6\frac{1}{4}$ in. by $4\frac{1}{2}$ in., so that, according to the distance between rebates of the two side rails, given in the chapter on the modern half-plate camera (p. 27), the grooving will need to be $\frac{5}{8}$ in. wide. If, however, the rails are not already fixed, they can be made to fit the grooving.

The frame must be made up with great exactness, thoroughly square and free from twist; it will be found best to make up the two halves of the slide together, treating them as one, as there is less chance in so doing of making a bad fit. The difficulty about this, however, is to get the halves to separate properly after gluing, as some glue generally gets between the join. The usual way of surmounting this difficulty is to rub a little beeswax or similar substance from the edge of the mitre 1 in. up the bar, thus preventing any glue which finds its way in from adhering. The glue used should be fairly thick and as hot as possible. The mitres should, of course, first be tested to see if they are perfectly square, and treated accordingly. Do not use joiners' brads for the corners, but insert a piece of veneer, as shown at A, Fig. 175, in each of the two saw-cuts, one on either side of the join, which should, of course, afterwards be trimmed down level (see also Fig. 134, p. 83, and the description accompanying it). Sufficient time, however, must be given to allow the corners to get well set before attempting this. If the two frames are already separated, they may more conveniently be put in the bench together, still treating them as one. If they afterwards refuse to separate, the edge of a knife must be used very gently. The two tongues for reversing-frame rebates are made ⅛ in., to fit side rails, by planing away the centre, and the cuts made to allow the catches, A (Figs. 177 and 178), to be screwed in flush.

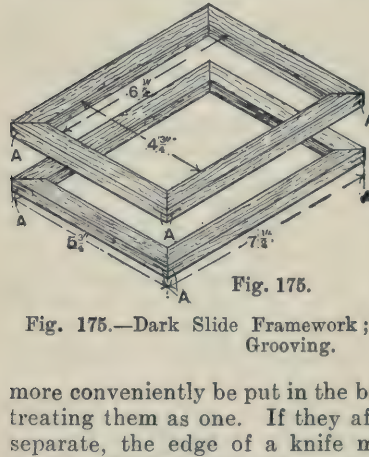


Fig. 175.

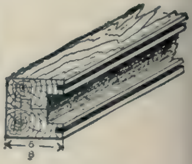


Fig. 176.

Fig. 175.—Dark Slide Framework; Fig. 176.—Double Grooving.

Smooth the edges of the frame, and cut the circular recess for the ivory number (B, Fig. 179, p. 120), and then cut away a portion of the top of the frame, as in Fig. 179, to allow of the insertion of the shutter. To do this, first make a series of saw-cuts of the same depth as the first groove (shown in Fig.

180), and chisel off the intervening parts; then smooth with sand-paper. Having got this level with the first rebate, cut the groove A (Fig. 179) for the shutter-stops; these prevent the shutter from being withdrawn too far. Continue the slide-grooves E out to the edge with a small chisel or bradawl, filing away any roughness. Immediately above the groove A chisel out a strip $\frac{1}{32}$ in. deep and $\frac{1}{4}$ in. wide, from C to D, and glue in a narrow strip of velvet. This ensures perfect contact with the shutter, and prevents the entrance of light. Screw on the catches A and hinges B (Fig. 177), also the two little clips C (Fig. 181), inside; and the flap F, made of firm card or metal, may be hinged on by cementing to the narrow strip of canvas B. The catches A (Fig. 177) go down flush with bottom of groove.

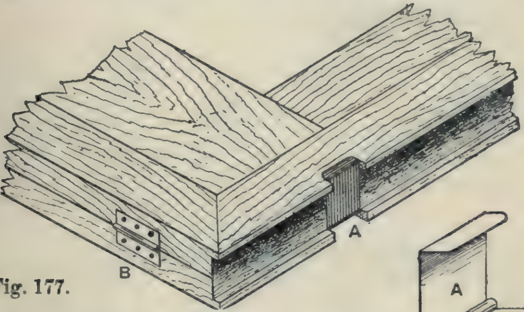


Fig. 177.

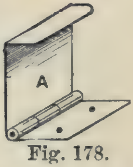


Fig. 178.

Fig. 177.—Framework with Hinge and Catch; Fig. 178.—Dark Slide Catch.

The shutters consist of four pieces of straight-grained mahogany, two $5\frac{15}{16}$ in. by $\frac{3}{4}$ in., on $6\frac{1}{2}$ in. by $3\frac{1}{4}$ in., and one $4\frac{3}{4}$ in. by $1\frac{3}{8}$ in. The first three are joined up and form C, D, E (Fig. 182), the projection for withdrawal being shaped according to taste, and a rebate is run round to exactly fit groove in framework. The three sides of the remaining piece G are rebated to match. Two saw-cuts are then made in

C, D, E, and G, at F, and a strip of opaque cloth inserted to form the hinge for folding the shutter forward on to the camera. The two edges taking the hinge must be bevelled off, as shown in Fig. 183, to allow of the bend. It now only remains to insert the shutter in slide, glue on the stops H, Fig. 181, and then fix in the ivory numbers and the turn-pins I; the latter are not essential. It is an advantage to screw two extra catches, K, Fig. 181, on the top, as in Fig. 184, to hold the slide tightly closed.

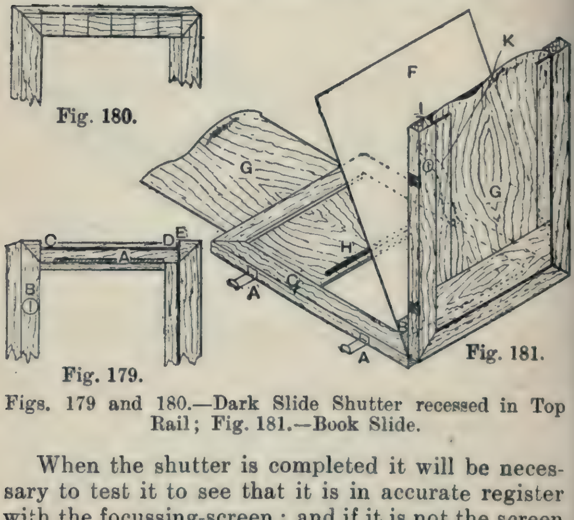


Fig. 180.

Fig. 179.

Fig. 181.

Figs. 179 and 180.—Dark Slide Shutter recessed in Top Rail; Fig. 181.—Book Slide.

When the shutter is completed it will be necessary to test it to see that it is in accurate register with the focussing-screen; and if it is not the screen must be altered to correspond. The ground side of the glass should be next the lens. To test, first focus sharply, then place a piece of ground glass in the slide, in the position occupied by the plate, insert very gently in the camera, and draw both slides. If correct, the image should be equally sharp. By turning the thumbscrew it may be found if the plate is farther from and nearer to the lens. A newspaper should be used for such a test, and full aperture of lens used. If these both register properly, and yet any picture taken with full aperture is out of focus, it will prove that the lens is an uncorrected one.

In the solid form of dark slide, now to be described, two plates are carried with a metal partition between. The plates and partition may be inserted from either side, and the shutters are hinged so as to fold over the back of the slide when the plate is being exposed. This solid slide is particularly adapted for use with the pocket camera described on pp. 78 to 96. Tobasca mahogany is a good wood for making it; softer wood does not give clean grooves.

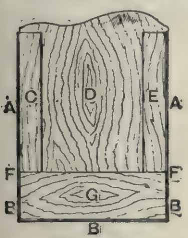


Fig. 182.

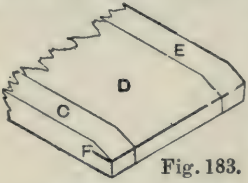


Fig. 183.

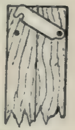


Fig. 184.

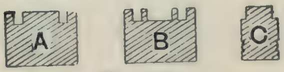


Fig. 185.

Fig. 182.—Dark Slide Shutter; Fig. 183.—Edge of Shutter; Fig 184.—Dark Slide Catch; Fig. 185.—Sections of Dark Slide Framing.

Failing the use of a small circular saw when cutting the small grooves and checks required in dark-slides, the gauge shown by Figs. 142 and 143, p. 87, can be used with great care. It is not worth while making less than six dark slides at a time, and so cut six pieces, 11 in. by $\frac{7}{8}$ in. by $\frac{9}{16}$ in., for sides, each piece forming two sides; three pieces 9 in. by $\frac{7}{8}$ in. by $\frac{9}{16}$ in. for bottom rails; and three pieces 9 in. by $\frac{3}{4}$ in. by $\frac{3}{8}$ in. full, for top rails. Plane the side and top pieces on the shooting board to be exactly $\frac{3}{4}$ in. by $\frac{1}{2}$ in. perfectly straight and square.

These pieces must now be grooved for the shutters. These grooves are $\frac{1}{8}$ in. deep, $\frac{3}{32}$ in. wide, and $\frac{3}{32}$ in. from each face, thus leaving $\frac{3}{8}$ in. solid in the centre. So far, the treatment of sides and bottom ends is identical, and they should be as shown in section at A (Fig. 185, p. 121). The three 9-in bottom rail pieces are now grooved as shown at B (Fig. 185), the groove being $\frac{1}{4}$ in. wide, $\frac{1}{8}$ in. deep, and exactly in the centre of the wood, thus leaving $\frac{1}{16}$ in. of wood between this and each of the former grooves. This $\frac{1}{4}$-in. groove is made by cutting a groove from each face, and cleaning out with a narrow chisel the narrow strip left in the middle.

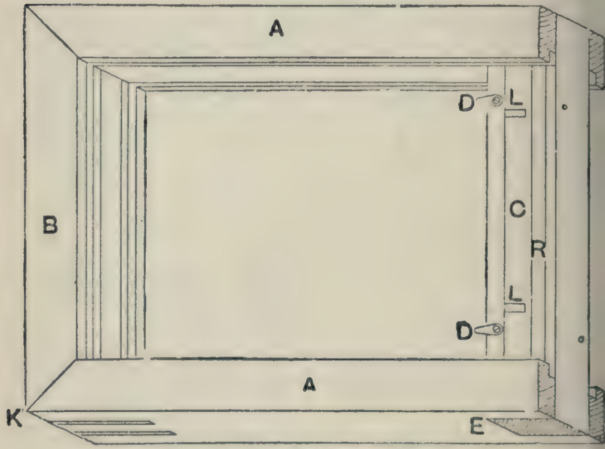


Fig. 186.—Dark Slide Framing.

The mitres on the side and bottom pieces now are cut. The bottom pieces, B (Fig. 186), are cut in the mitre-box so as to be $3\frac{3}{8}$ in. long on the shortest side, which will be the side with the groove in it. They are then planed up on the mitre-board so as to be just $3\frac{1}{4}$ in., plus $\frac{1}{32}$ in. These measurements must be adhered to strictly. To avoid breaking plates that may be a fraction larger than usual, this $\frac{1}{32}$ in. of clearance should be allowed always; any more is unnecessary, and would allow the plates to rattle about. In Fig. 186, which shows the dark slide framing in conventional perspective, A indicates the side pieces; B, bottom rail; C, top rail; D turnbuttons; E, end of top rail; K, veneer keys of mitred joint; L, cheeks into which screws slide when shutter is pulled out; and R, velvet glued into groove.

In order to get above measurement exact, and to have the slides and other parts of the camera uniform, a series of special marking gauges, as shown by Fig. 187, A, B, and C, may be used; these saving a great deal of time in the long run. A scrap of mahogany about 4 in. by 1 in. by $\frac{1}{4}$ in. has two small steel brads driven in and filed to a point, taking care to have the points just $3\frac{1}{4}$ in. plus $\frac{1}{32}$ in. apart. Each bottom piece is marked with this gauge, and planed down on the mitre-board till the marks are no more than visible, when they will be just the length.

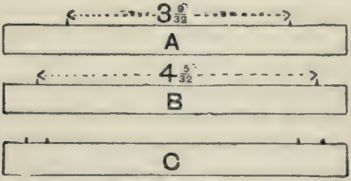


Fig. 187.—Marking Gauges.

Each of the 11-in. by $\frac{3}{4}$-in. pieces makes two sides, and has to have a mitre cut on each end. A marking gauge as at B (Fig. 187) is applied from each end, the single point being placed just at the beginning of the mitre, and the double points at the other end will mark the breadth and position of the top rail. The marks made by the double points should be continued round the pieces with a square and the point of a knife, taking care to mark very lightly on the face. The inside mark shows the end of the slot to be cut for the top rail, whilst the outer mark shows the extreme length of the side, which may now be cut off at that mark. To mark this slot, set an ordinary marking gauge to $\frac{1}{4}$ in., which is the distance that the groove in the bottom pieces, B (Fig. 185, p. 121), is from the face. The slot is marked with this gauge on both edges and from both faces; the space left between the gauge marks should be $\frac{1}{4}$ in. This piece is cut down with a dovetail saw, and cut out to the gauge line with a sharp, narrow chisel.

The top pieces, which have already been sawn to 9 in. by $\frac{3}{4}$ in. by $\frac{3}{8}$ in. full, now are gauged and planed up to $\frac{11}{16}$ in. by $\frac{3}{8}$ in., and checked on both sides of one edge, as shown at C (Fig. 185, p. 121). The solid part in the centre is exactly $\frac{1}{4}$ in. to correspond with the groove in the bottom rail. This will cause each check to be $\frac{1}{16}$ in. deep, and they may be made $\frac{7}{32}$ in. wide, so as to leave room for the turn-buttons D (Fig. 186, p. 122); but if made any wider, they will contract the bearing of the shutter when pulled out. The best way to cut this small rebate is by gauging both breadth and depth with the marking gauge, and planing down the check with a small iron bullnose rebate plane, using a cutting of wood held firmly to the gauge mark till the check is fairly started, and cutting down on the line of the gauge mark with a knife after every two or three shavings. The length of the tops and the check which is to be cut on each end to fit into the slot, E (Fig. 186) are marked with the gauge marked C (Fig. 187). The outer points mark the length to which the top is cut; the inner points mark the shoulders of the check at each end. The gauge used to mark the depth of the check may now be run across the end and along the top of the shoulder on both sides, and the cheeks cut down with a dovetail saw and pared down with a chisel to fit into the slots in the side pieces. The velvet ribbon R (Fig. 186) should now be glued in, one on each side, as shown at C (Fig. 185), the tool shown by Fig. 136, p. 83, being used. The dark slides now are ready to be glued up. The glue for this purpose must be fairly thick and very hot. Thin glue would sink into the end wood of the mitres, and the slides would probably come asunder in the keying. Take a flat piece of board, long enough to contain the six glued-up slides side by side, with a space between, and begin by gluing the mitres at the bottom corners and pressing them firmly together with the fingers. If the glue is right, they will stick at once; the pieces should be warmed before gluing. After leaving overnight on the board to harden, the top pieces may be glued in, taking care, in doing this, not to undo the bottom corners, as until they are keyed they require careful handling. When top and bottom joints are quite hard, the grooves may be cut for the keys which are shown at K (Fig. 186, p. 122).

The turn-buttons, D (Fig. 186), are now screwed on, observing to keep the screws from meeting by placing the turn-buttons not exactly opposite—say, ½ in. from each end on one side, and ⅝ in. from each end on the other. This completes the framework.

In Fig. 188, the face view of the dark slide shutter, A, is the centre piece; B, narrow pieces forming hinge; C, bottom piece; G, projection for gripping shutter; H, side pieces; and K, screws to prevent entire withdrawal of shutter.

The dark slide shutters, when finished, will be $\frac{3}{16}$ in. thick, and are made from ¼-in. wood; the face view of finished shutter is shown by Fig. 188, other views being shown by Figs. 189 and 190. Cut two pieces 12 in. wide by 2 in. long by ¼ in., and four pieces 12 in. long by ⅞ in. wide by ¼ in. These will make shutters for three double slides. Join these pieces by means of a veneer tongue as shown by Fig. 190, p. 126. First plane up both edges of the broad pieces straight and square on the shooting board, then one edge of each of the narrow pieces. Take a stout veneer for the tongues or feathers, and set the saw gauge so as to make a groove about $\frac{1}{4}$ in. deep in the edge of the wood, which will just fit the veneer, keeping the groove rather nearer to one side for preference. The strips of veneer are cut off with the marking gauge set to $\frac{7}{16}$ in.; a cut is made with the gauge on both sides, and the strip will break off. This strip is taken from the end of the piece of veneer, and not from the side. This makes a stronger joint than if cut the way of the grain. Prepare six pieces 3$\frac{5}{8}$ in. by 1 in. by $\frac{1}{4}$ in., marked C (Fig. 188), and eighteen pieces 3$\frac{5}{8}$ in. by $\frac{1}{4}$ in. by $\frac{1}{4}$ in., marked B (Fig 188). Plane them on both sides, and shoot straight both the edges. The three narrow pieces of each shutter form the hinge which allows the shutter to fold over behind the dark slide during exposure of the plate. The hinge is made of best quality black American cloth, perfectly opaque, but not very

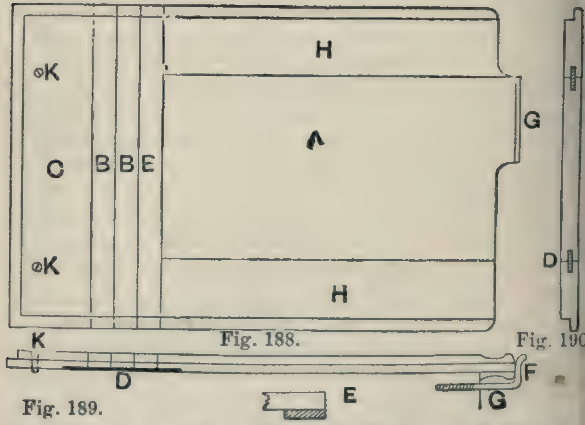


Fig. 188.

Fig. 190

Fig. 189.

Figs. 188, 189, and 190.—Plan, Side View, and Section of Slide Shutter.

thick. When the glue is quite hard, the clamped pieces which are to form the shutters are planed perfectly straight and flat on the side which will be the back when finished; the outside is only roughly planed meantime. It is better in this planing of the back to plane down to within $\frac{1}{16}$ in. of the feather; otherwise, when the shutter comes to be finally planed down to its thickness, the feather may appear on the face, which would weaken it and spoil the appearance. Cut each piece into three lengths of $3\frac{5}{8}$ in. each, and square one end of each on the shooting board, the edges being still left rough.

The marking gauge is set to $\frac{1}{4}$ in., and the check for the hinge marked, and then planed down just deep enough to receive the thickness of the American cloth. A similar check is planed on one edge of each of the $\frac{7}{8}$-in. by $\frac{1}{4}$-in. pieces. These checks (shown in section at D, Fig. 189) can be planed with a little iron rebate plane.

The gluing of the cloth hinges requires great care, and may be done in several ways. A good plan is to lay them on the top of an iron plate over a gas-burner, and keep them at such a heat that they can just be handled. Lay down a shutter piece, three pieces $\frac{1}{4}$ in. broad and one piece $\frac{7}{8}$ in. broad, side by side, with the checked sides uppermost and towards each other, and measure from one check to the other; this gives the breadth of the cloth hinge, which should be just $1\frac{1}{4}$ in. Cut as many strips to this breadth as there are shutters, using a knife and a straightedge in preference to scissors. Glue the check on the shutter piece, and lay one of the cloth pieces in position, work it down with the fingers, and set aside. Use hot and fairly strong glue.

Proceed in a like manner with all the other shutter pieces, keeping, of course, the rough side of the cloth next the wood. The shutter piece is next laid on a flat board in the position shown in the view (Fig. 189); glue is spread evenly over the cloth, but kept carefully off the edge of the wood, and the three ¼-in. pieces and the checked ⅞-in. piece are firmly glued down to the cloth. If they are warm, they will set very quickly and stick well. Each shutter is glued in the same manner and put away to harden. If too much glue is put on, some of it may get up between the edges of the wood, and something will have to give way before that hinge will work. The edges where glue is not wanted may be greased to prevent the glue from sticking. Owing to the impervious nature of the cloth, the glue should be allowed about thirty-six hours in which to dry.

When quite dry, the shutters are planed up to their proper size, measured to the bottom of the grooves, and carefully checked round three sides so as to slide easily but not loosely, by means of the marking gauge and the small iron rebate plane. When the shutters have all been fitted into place, they should be numbered on the back, and corresponding numbers marked on each side of the top rail of the slide, so that they can be easily replaced. They will still be too thick, and will project on the face above the slide frame. This over-wood must be planed off and each shutter made perfectly level with its frame. They are still rough on the top edge (the right-hand end in Fig. 186, p. 122), and should project ½ in. beyond the top rail of the slide when pushed home into the groove.

Across the back of each shutter glue a piece 3½ in. by ½ in. by ⅛ in., as shown at E (Fig. 189), so that when the shutter is in position in the slide this piece will just bear on the top bar and form a check to keep out light. But its most important use is to form a grip for the fingers where it is hollowed out on both sides, as shown at F (Fig. 189), which is done by means of a plane known as a casement. After the hollow has been made on each side, and smoothed by means of sandpaper and a small piece of cork, rounded to fit the hollow, the shutters are cut as shown at G (Fig. 188), leaving a projecting thumb-piece towards one side. When the other shutter is inserted, the projection on one will be opposite the blank on the other, enabling the thumb and forefinger to grip the shutter easily.

In order to prevent the shutters from coming out entirely, two small screws, K (Figs. 188 and 189), are put through them about $\frac{1}{8}$ in. from the bottom edge, and projecting $\frac{1}{16}$ in. beyond the back surface of the shutter. Little grooves, L (Fig. 186, p. 122), are then cut in the top rail of the slide to allow the shutter to pull far enough out to give access to the turn-buttons, D.

A thin piece of tin or ferrotype plate, $4\frac{1}{4}$ in. by $3\frac{1}{4}$ in., blackened with a dead black (see p. 49), to serve as an opaque partition between the sensitive plates, completes the dark slide. This partition should have a light brass spring riveted or soldered in the middle of it to keep each plate hard up to its rebate, and so ensure a correct register. The screwed turn-pins, G (Fig. 189), are to prevent the shutters from opening accidentally.

The dark slide is now cut down all round so as to lie in the check prepared for it in the back of the camera body, as shown at Fig. 135 (p. 83). When all the slides have been planed so as to fit in easily, the four brass plates, D (Fig. 135), are prepared and screwed on the edge of the camera body. They are each 1 in. long, $\frac{3}{8}$ in. broad, and about $\frac{1}{16}$ in. thick, and each is fixed with two screws so as to project $\frac{1}{8}$ in. inside the edge of the body. The dark slides are grooved on both edges and from each side, so as to slide into position easily, but without shake, and bearing on the check all round, particularly at the sides where the velvet ribbon is. The little brass turn-button, K, Fig. 129 (p. 77), keeps the slide in position during the withdrawal of the shutter.

CHAPTER IX.

EXPOSURE SHUTTERS.

PERHAPS the simplest form of exposure shutter is a flap of wood hung over the lens, as illustrated by Fig. 191. If the wood works freely in the pivot, yet fits well, and is covered on the inside with a piece of velvet, it will be found a simple and extremely good method of exposing. It will be an advantage to work it by means of a piece of silk cord attached to the end and brought over a pulley or through an eye as illustrated, as then there will be less chance of vibration; in which case it is better to work it behind the lens. Owing to the difficulty of giving short exposures with such a shutter, and other disadvantages, there are many cases, hand cameras, for instance, in which it cannot be used. The shutters described below work in but little space, and have certain advantages which the drop does not possess. The kind of wood used for shutters is not important, but mahogany is to be preferred, as, for one reason, the shutter looks better when finished. A piece of a cigar-box answers the purpose admirably.

The single flap shutter (Fig. 192) is a very simple type, consisting of a flap, A, which is raised by a rubber band, and is closed by means of a weighted arm, B, attached to it. For convenience of description, it is assumed that the shutters described on pp. 130 to 143 are to be made for a lens whose greatest working aperture is 1 in. The dimensions can be calculated easily for a smaller aperture. The back of the shutter is a rectangular piece of wood about ⅛ in. thick, and not less than 1½ in. broad, the breadth being about ¼ in. more than the diameter of the hood, or mount, of the lens the shutter is to fit; the length will have to be determined later. On the back of this wood, and equi-distant from three of its edges, mark out a circle having a diameter equal to that of the lens mount; bore a small hole through the centre of the circle, and with this hole as centre, on the other side of the wood mark a square of 1¼ in. side. Cut away the wood enclosed by this square to a uniform depth of about $\frac{1}{16}$ in., and then bore a hole of $\frac{1}{16}$ in. diameter by means of a centre-bit right through the wood, its centre being the small hole already bored. Reference to Figs. 193 and 194 will make this clear.

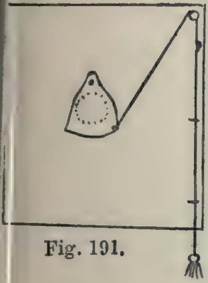


Fig. 191.

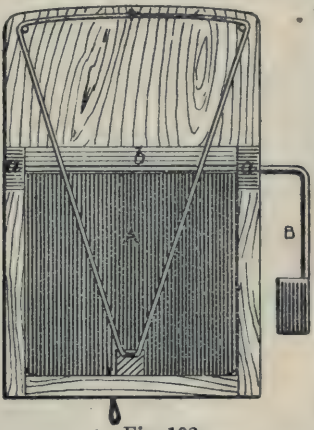


Fig. 192.

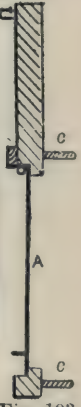


Fig. 193.

Fig. 191.—Simple Shutter; Figs. 192 and 193.—Single Flap Shutter.

For the shutter flap, cut out a square piece of tin-plate or brass to fit easily the square recess in the wood. Thoroughly clean the metal flap, and dead-black it (see p. 49). Solder a piece of stout brass or tinned iron wire 3 in. long across one edge of the unblacked side of the flap, leaving about 1 in. projecting over one side (see Fig. 195); bend the projecting end at right angles at about ½ in. from the flap, slightly inclining it to the front of the flap, and solder a small lead weight to the end of the bent wire.

A projecting piece must be attached near the lower edge of the flap for an elastic band to be stretched over. To do this, cut a piece of thin tinplate ⅜ in. by ¼ in. along the full lines shown in Fig. 196, and bend back the pieces *a a* behind *b*, and hammer flat. Now bend *b* at right angles to *c*, and solder to front of flap as shown in Fig. 192. It is well to run a little solder behind *b* to prevent it being bent back; also file off any sharp corners.

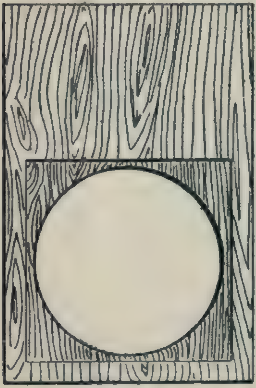


Fig. 194.

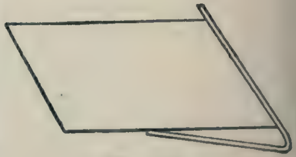


Fig. 195.

Fig. 194.—Back of Shutter; Fig. 195.—Shutter Flap.

The flap is now complete, and two grooves should be cut across the wooden back, so that when the flap is placed in the recess the wire does not prevent it from fitting closely over the hole. It is well to glue a piece of thin cloth round the lower part of the hole, and so prevent the tendency to rebound when the flap falls. Small wooden caps, *a a* (Fig. 192), are glued on so as to keep the wire in position, and a thin strip, *b* (Fig. 192), across above the wire, so that the flap cannot open to more than 135° ; otherwise, it will not close again without aid.

Two small tacks or pins are now driven into the back at the top corner, and a pin into the centre at the top, as shown in Fig. 192, p. 131 ; this pin is bent to form a hook. In using the shutter, an india-rubber band is placed over the hook and stretched over the projection on the flap ; when released, the band gives an upward movement to the flap. To give a shorter exposure, the band is stretched across over the two tacks and the projection. Care must be taken to place the pins so that the rubber band will detach itself from the flap when full open, thus allowing it to close again by the downward pull of the weighted arm.

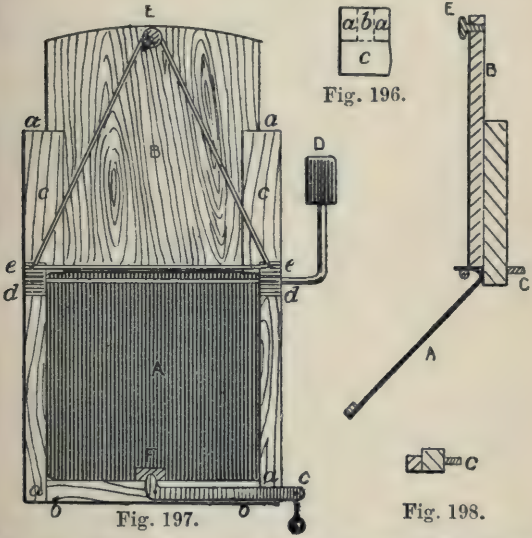


Fig. 196.

Fig. 197.

Fig. 198.

Fig. 196.—Catch ; Figs. 197 and 198.—Drop and Flap Shutter.

A catch to keep the flap closed must be added; all that is necessary for this is a pin pushed through the bottom of the wood so as to pass in front of the flap when closed, and capable of moving up and down easily. The head should be upwards, and a small hollow should be made for the head when the pin is pulled down or the flap will not open. The bottom end may be bent into a loop, and a cord attached. If preferred, a catch like that described for the next shutter (p. 137) may be used.

The single flap shutter, though inferior to the drop and flap shutter, works well for moderately slow exposures (half a second to one-tenth of a second), but is not suitable for more rapid exposures. It has the valuable advantage of giving a larger exposure to foreground than sky, the higher and better lighted parts of the subject getting less exposure than lower and generally less illuminated parts.

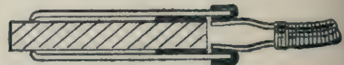


Fig. 203.

Fig. 199.

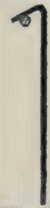


Fig. 200.

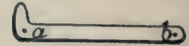


Fig. 201.

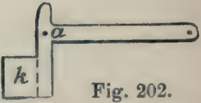


Fig. 202.

Figs. 199 and 200.—Shutter Flap; Figs. 201 and 202.—Shutter Catches; Fig. 203.—Pneumatic Release.

For the purpose of fitting on to the lens mount, a short piece of cardboard or paper tube (made by pasting a number of turns of paper together round a roller), or a wooden ring which just fits the mount, is glued to the back of the shutter, *c c* (Fig. 193), so as to be concentric with the hole. Care should be taken that this collar is in contact with the back all round, so that light cannot get through to the lens between collar and back of shutter.

The shutter about to be described is a combination of a drop and flap shutter. It gives the longest exposure to the foreground, often allowing real cloud effects to be obtained in a negative, and can easily be regulated to give exposures from about three-quarters of a second to one-twentieth of a second, or even less. It is shown by Fig. 197, p. 133, and is seen to consist of a flap, A, released by a catch, C, and opened by means of a weighted arm, *d*. When fully open it allows the drop, B, to fall and close the aperture.

The back of the shutter is a piece of mahogany about $\frac{1}{8}$ in. thick, $2\frac{1}{4}$ in. long, and $\frac{1}{4}$ in. broader than the diameter of lens hood, or mount, which the shutter is to fit. The breadth should not be less than $1\frac{1}{2}$ in., however (preferably greater). These measurements, as before, are for a shutter to be used with a lens working at a maximum aperture of 1 in. Draw a pencil line lengthwise down the middle of the wood, and taking a point $\frac{7}{8}$ in. from one end of this as centre, bore a hole of $1\frac{1}{16}$ in. diameter through the wood. The front surface of the back should now be made perfectly smooth by sand-papering, finishing off with a piece of worn-out sand-paper.

The drop, B, should be made of a piece of vulcanised fibre or wood, not more than $\frac{1}{12}$ in. thick; it should measure $1\frac{1}{2}$ in. by $1\frac{1}{4}$ in., and should be quite rectangular. Both the sides and edges should be rubbed down smooth. The top may now be rounded off as in Fig. 197, p. 133, and a small wooden knob, E, fixed into the centre of the top. This serves both for lifting the drop and to stretch a rubber band over. Fig. 198 shows a section through the centre of the shutter.

Cut two strips of wood scarcely thicker than the drop, $2\frac{1}{4}$ in. long and a little more than $\frac{1}{8}$ in. broad, and, having smoothed the edges, glue them to the front of the wood back, one at each side (see *a a*, Fig. 197). They must be placed parallel to one another, so that the drop can slide between them without friction, but at the same time having no appreciable lateral play. Also glue a piece of wood of same thickness, and ¼ in. broad, across the bottom, *b b* (Fig. 197).

Make the flap of a piece of tin-plate of the same breadth as the drop, and 1½ in. long. Black the back side of it as described on p. 49. Bend it sharply across at a distance of 5/16 in. from one edge, as shown in Fig. 199, p. 134, taking care that, except just at the bend, the metal is not curved. Then solder a stout wire across the flap, as shown in the section of flap, Fig. 200, keeping the wire parallel to the edge, and at a distance of ⅛ in. from the bend, measured to the centre of the wire. The wire should project over the flap at one side about 1½ in., and at 1 in. from this end it should be bent at right angles, but so that when the flap is held vertically the bent limb of the wire should incline backwards at from 10° to 20°. A weight is then soldered to this end of the wire, as in the previous shutter. A small piece of brass or other hard metal a little less in thickness than the piece *b b* (Fig. 197, p. 133), say, 1/16 in.—is soldered to the bottom of the flap, as shown at F. Place the flap on the back of the shutter in proper position, so that the black side is next the hole, and the lower edge of the flap all but touches the piece *b b*, which may require bevelling at the upper edge in order that the flap can open and close.

Cut strips of thin wood ¼ in. broad (*c c*, Fig. 197), and glue them over the side pieces, *a a*, so that they are just in contact at their lower ends with the wire of the flap. These serve to partly fix the flap in position and prevent the drop from falling forward. Also glue a small piece of wood immediately below the wire at each side, and two pieces, *d d*, over the wire, which fix the flap so that it can only rotate about the wire.

The collar by which the shutter is fitted to the lens mount should now be glued on, as described for the previous shutter.

Next bend two pins, and fix one at each side of the shutter, as shown at *e e*, for the purpose of stretching across an elastic band, which also passes over the knob E, by which means a quicker exposure is obtained.

The catch, or release, is made by cutting a piece of metal, as shown in Fig. 201, p. 134, and drilling small holes at *a* and *b*. This is then fastened by means of a pin to the middle of the piece *b b'* in Fig. 197, in such a way that it can turn about the pin, so that when the arm is horizontal the flap is just prevented from opening. A cord may be attached through the hole, *b*, on pulling which the flap will be released. If an elastic band is not employed, the flap is opened by the weighted arm, and as soon as it is fully open it allows the drop to fall, and thus closes the aperture which admits light to the lens. By this means an exposure of half to three quarters of a second can be given. If an indiarubber band be stretched over the knob and the two pins, the drop is caused to press on the short bent-over piece of the flap, causing the flap to open more quickly when released; in addition to this, the drop is made to fall more quickly, both of which shorten the time of exposure.

Any rough parts of the shutter should now be finished off, and the wood polished or varnished. The flap, if of brass, may be polished and lacquered, or, if tin, may be given a coat of black enamel, which greatly improves its appearance. If preferred, this could be done before the flap is fixed in position; but as the enamel takes some little time to harden, the shutter must be left a few days before finishing.

If a pneumatic release is to be attached to this shutter, the catch for holding down the flap must be somewhat modified ; a suitable catch is made by cutting a piece of tin-plate, as shown in Fig. 202, p. 134, and boring a hole at *a*, as before. The piece *k* is bent back at right angles along the dotted line, and the catch then fixed to the shutter. A piece of glass tubing 1 in. long, and ¼ in. to ¾ in. bore, is wanted ; one end should have its diameter lessened by drawing out in a Bunsen or spirit lamp flame. Get a piece of glass rod 1 in. long, or a metal rod, of such a thickness that when a piece of thin indiarubber tubing ¼ in. to ⅜ in. long is stretched over one end it will fit the tube, moving readily up and down, but fitting as air-tight as possible. Place this in the tube so that the rubber-covered end is next the end of the glass tube which has not been contracted. By means of a bit of rubber tubing a short piece of glass tubing is fitted into this end, and by means of this the indiarubber ball and tube can be fitted.

Fig. 203, p. 134, shows the release in section. This release must now be fixed to the bottom of the shutter in such a manner that, when set, the end of the piston-rod, when pushed back as far as it will go, is in contact with *k* (Fig. 202). On squeezing the ball, the piston is pressed against *k*, and by moving it releases the shutter.

If the lens mount be not greater than 1 in., or if there be very little difference between the diameter of lens mount, or hood, the shutter is to fit and the greatest aperture at which the lens will work, the collar at the back need not be adopted in either of the shutters above described. Instead of this, the back should be made of rather thicker wood, and the hole bored in it made the same as the external measurement of the lens mount. In following the above directions, the shutter should, of course, be made as if this hole were the greatest working aperture of the lens. The back of the shutter now fits on to the lens mount instead of the collar.

The repeating shutter works on an altogether different principle from either of the preceding. It consists of two pieces of wood, each having a hole in the middle, which pass one another in front of the lens, thus making the exposure. It is difficult to work this shutter so as to give a moderately slow exposure; but exposures of about one-eighth of a second and less are easily obtained. Its advantages are that it opens from and closes towards the centre of the lens, the small part of the lens immediately round its centre being thus open during the greater part of the exposure, and also that when once set any number of exposures can be made without uncovering the lens except during the exposure. This latter is very desirable, and often necessary with magazine cameras. Fig. 204 is a view of the shutter when set, and Fig. 205 shows a plan of the frame of the shutter.

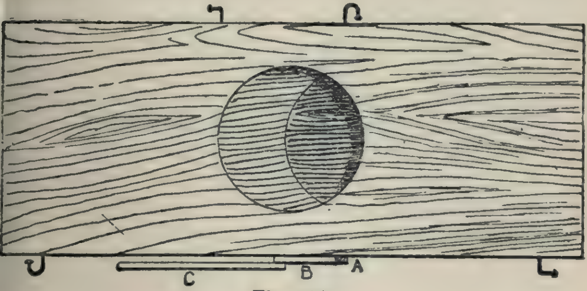


Fig. 204.

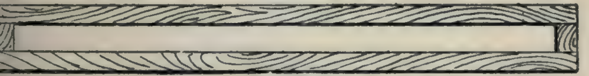


Fig. 205.

Fig. 204.—Repeating Shutter; Fig. 205.—Plan of Frame.

To make the shutter, a piece of mahogany or other suitable wood is carefully planed to $\frac{1}{12}$ in. in thickness. Its surfaces are made perfectly smooth, and then two exactly similar rectangular pieces are cut, each measuring 2⅜ in. by 1½ in., and their edges are rubbed down smooth. On one face of each mark lightly the diagonals, and, with their intersection as centre, bore a hole 1 in. in diameter in each (see Fig. 205, p. 139).

Next cut two pieces of wood to form the back and front of the shutter, each measuring 3⅞ in. by 1½ in., and bore a hole 1 in. in diameter in each exactly as before. Both these and the two shorter pieces should be cut with the grain of the wood running along the length. Now cut two strips of wood of ⅛ in. to 3/16 in. thick, and 1½ in. long by ⅙ in. broad, to form the ends. By firmly gluing these across the ends of the front and back pieces, these are held together as shown in the plan Fig. 205. The two 2⅜-in. by 1½ in. pieces slide between the front and back pieces so fixed. Before gluing, the internal surfaces of the wood may be blacked, and also the two surfaces of the sliding pieces, which are to be turned towards the lens (see pp. 48 and 49). The blacked surface, if necessary, should again be smoothed with a piece of worn-out sand-paper.

Fix pins in the sliding pieces about ⅛ in. from the end, two in each, as shown in Fig. 206. For clearness, the two pieces are shown in the figure one beside the other, but really one is behind the other.

Cut pieces of good cardboard (a stout postcard will do) 3⅞ in. long, and the same breadth as depth of the shutter; glue these on to the wood so as to completely enclose the sliding pieces, one across the top and the other across the bottom of the shutter. Before doing this, however, cut narrow slits for the pins of the sliders to pass through and to allow them to move, as the sliding piece travels from one end to the other. This is shown in Fig. 207. Another narrow slit about ⅛ in. long must also be cut crosswise, and about the middle of the lower piece only.

The upper piece of cardboard may now be glued in position, and the lower piece temporarily placed in position. Now bring the sliding pieces one to each end, so as to completely close the front and back apertures, as is done when the shutter is set, and accurately mark the edges where they come opposite to the cross slit. Next bring the sliding pieces to the opposite ends, so as to again close the shutter, and again mark where the edges are opposite the slit. Now remove the sliders, and at each of the four marks cut a notch about $\frac{1}{16}$ in. deep with a fret-saw or other tool capable of making a fine notch (see Fig. 206). The object of these notches will be seen later. The sliders may now be replaced, and the lower piece of cardboard glued on. It is well to blacken the inside surfaces of the cardboard.

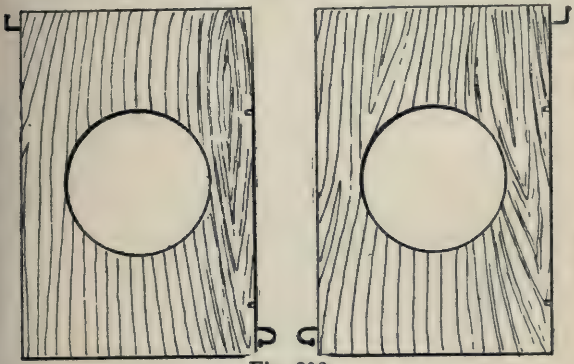


Fig. 206.

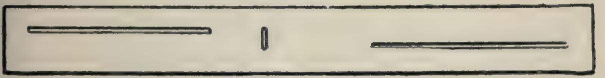


Fig. 207.

Fig. 206.—Sliding Pieces; Fig. 207.—Cardboard with Slits;

The catch shown by Fig. 208, p. 143, consists of a small piece of brass, A, which, by means of two small pins, can be fastened to the bottom of the shutter crosswise. To the under side of this, and at right angles to it, is soldered a short piece of narrow watch-spring, B, the free end of which has been softened and about $\frac{1}{8}$ in. turned up at right angles. C is a bent wire, which is soldered to the free end of the spring. In soldering the watch-spring, the part to be soldered should be dipped in zinc chloride solution, and then well tinned with the soldering-iron before it is attempted to solder the brass. The piece A is then firmly fixed so that the turned-up end of the spring passes through the cross-slit in the cardboard.

The working of the shutter can now be explained. First, the two sliding pieces are brought to opposite ends of the shutter, thus closing the lens aperture. As soon as this is done, the spring presses itself into the two notches of the sliders which are opposite the slit, and thus they are prevented from moving. A rubber band is now stretched across the two pins, which are at extreme ends of the shutter. On pulling the arm C of the spring catch, which must be immediately released, and not held down, the sliding pieces are released, and by means of the elastic band are made to pass before the lens to the opposite ends. As soon as this has occurred, one of the notches of each piece is brought opposite the cross slit, and the end of the spring is at once pressed in, thus fixing them again. In this movement of the sliders the lens has been uncovered from the centre until full open, and then closed to the centre. All that is now necessary to give another exposure is to remove the rubber band from one of the pins, and stretch another band across the two pins at the opposite ends of the shutter, and then release as before. Very short exposures indeed may be given by using one or more strong indiarubber bands.

All that now remains to be done is to fix the collar at the back of the shutter, by which it can be fitted to the lens. This is, perhaps, preferable to making the apertures of the shutter large enough to fit the lens mount. The shutter can now be polished or finished off in any suitable way that may recommend itself.

When the shutter is closed, it may be that light can find its way to the lens through the slits at the top. This difficulty can be got over by bending a piece of thin cardboard the length of the shutter into a semi-cylindrical form (Fig. 209), and gluing in pieces at the ends. This should equal in breadth the depth of the shutter, and can be hinged along its length to the back of the shutter, and turned over so as to cover the top after the elastic band has been manipulated.

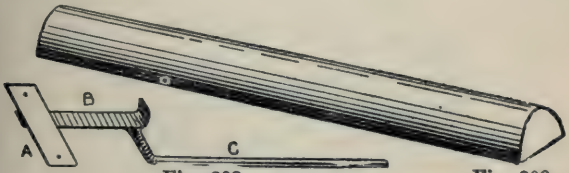


Fig. 208. Fig. 209.

Fig 208.—Spring Catch; Fig. 209.—Cover for Top of Shutter.

In portrait photography, and in the production of pictures having artistic merit, there are undoubted advantages in taking the picture without the knowledge of the model at the exact moment. For this purpose are found almost useless the ordinary lens cap and those shutters that go off like an alarum clock; and the only shutter of service must be simple in construction, practically without vibration, invisible, noiseless, and capable of giving almost any desired length of exposure. The shutter about to be described fulfils all the above requirements, and has therefore been adopted for studio work by a very large number of professional photographers.

In making it, first construct a framework of thin mahogany, two pieces 5 in. long by $1\frac{1}{4}$ in. broad, and two pieces 4 in. by $1\frac{1}{4}$ in. (A, A, A, A, Fig. 210). This framework is divided into two compartments by A^1 (same width), 1 in. from end. Two pieces must now be cut 4 in. by 1 in. to fit over and form top and bottom of the box containing the works. Before fitting either of these, finish the works. Shape the rod of wood, B, about $\frac{3}{8}$ in. diameter, running in holes, C, C, C. The centre hole is in A^1. Into this rod fix wire, N, bent as in Fig. 211. Afterwards rod and wire are covered by straining black velvet on either side to form a flap. Now construct a frame in 1-in. deal shaped like dotted lines X around the flap, and paint it black. The flap rests against this, and it prevents light entering around the edges of flap, or when fitted against camera front.

Around the roller, B (Fig. 210), glue a strip of tape, D, 2 in. long; this must be wound round roller, leaving $\frac{1}{4}$ in. that may be glued to strip of wood shaped as L. Another piece of tape, E, $\frac{1}{2}$ in., is glued to bottom of wood strip, L, and to framework, and forms a hinge upon which the strip works. It will now be seen that what is required is the means of applying pressure at the top of strip which will cause the tape to unwind, the rod to revolve, and therefore the flap to be raised. To do this, 1 in. of brass tube, $\frac{3}{16}$ in. diameter, must first be fixed through the framework at F, to protrude $\frac{1}{2}$ in. on each side. Over this is fitted a rubber pipe with bag attached, as in Fig. 212, which shows shape of air-tight bag when inflated. The rubber tube is fitted over that portion of the brass tube inside, and then is glued into position shown in Fig. 210. A wire spring, G, must now be fastened to the rod B at H, and to the side to rewind the tape. The works being finished, screw on top and bottom already made to enclose them. The bottom should be let in level with the two sides. The brass catch, I (Fig. 210), may now be fixed, together with the pin, J, so that, when necessary, the catch may be held up by the pin, thus keeping the shutter open as long as required, and taking the strain off the two bulbs. The shutter is now ready for fixing inside the camera. Screws through the two screw-plates, K, at side will do this. See that it fits flush against camera front. A yard of rubber tubing is required. At one end of this is a bulb and tap, as shown at Fig. 213; the other end is brought through the bottom of camera and fitted over the outer projection, F 2. The shutter is now complete, and, if properly made, should answer instantly to slight pressure of bulb, its action being to inflate the compressed bag in the shutter, which unwinds tape, etc. The shortest exposure it gives is about ¼ second. This is quicker than is required for all ordinary work. When focussing, press the bulb and turn tap; the shutter will then remain open till tap is released. In Fig. 210 the works are shown larger than they are in proportion, in order that the construction might be clearer. If the shutter makes a noise by hitting against bellows at top, a little loose

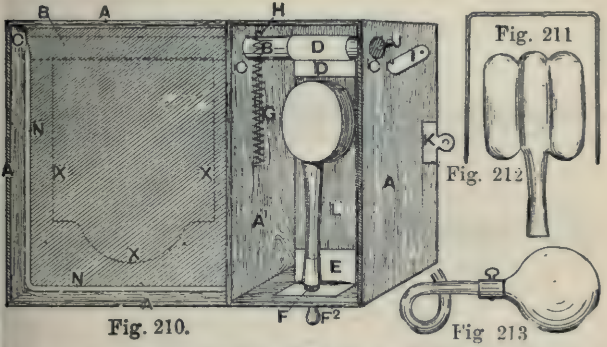


Fig. 210.—Flap Shutter to work inside Camera; Fig. 211.—Rod Wire; Fig. 212.—Inflated Bag; Fig. 213.—Bulb and Tap.

cotton-wool covered with velvet tacked to end of flap will prevent this. It is an advantage to bevel the inner edge of the top piece, A (Fig. 210). The outside may be polished, and the inside dull-blacked.

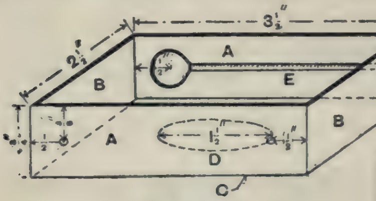


Fig. 215.

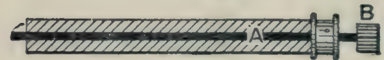


Fig. 216.

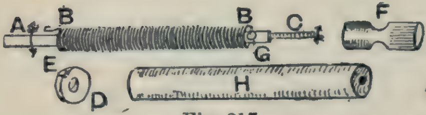


Fig. 217.

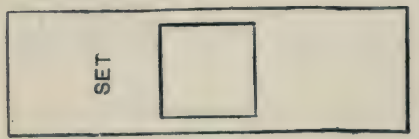


Fig. 218.

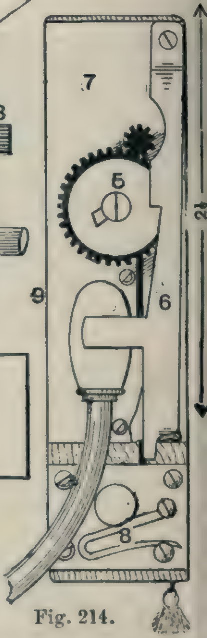


Fig. 214.

Fig. 214.—Time and Instantaneous Shutter; Fig. 215.—Framework; Fig. 216.—Top Roller; Fig. 217.—Spring Roller; Fig. 218.—Blind.

One of the best types of time and instantaneous shutter is shown complete by Fig. 214. A field shutter should not be bulky or heavy, and should be capable of giving a variety of exposures, and a shutter fulfilling these requirements, and one which, in an expert's opinion, is superior to all others, is the roller-blind time and instantaneous shutter. Although necessarily somewhat complicated, owing to the amount which it undertakes to do, yet it is by no means liable to go wrong, and the mechanism, though slight, will last well.

Before dealing with this shutter in detail, a brief description must be given of it as a whole. The lens is covered before and after exposure by a blind, which is wound to set and rewound to expose upon two rollers. The rewinding is done by a spring contained in the bottom roller. By pulling a string the shutter is set, and the exposure is made by pressing a rubber ball, which inflates a bulb, raises a catch, and releases the spring. The greater the number of times the spring is wound, the greater is the speed of the shutter. When exposures of more than one-fourth of a second are required, the revolving of the rollers is resisted half-way by another catch, which causes the shutter to remain open as long as the ball is pressed.

The shutter here described would be suitable for use with a half-plate camera, the lens of which would probably be about 1 in. to 1¼ in. diameter. First the outer case or framework (Fig. 215) is made in mahogany ⅛ in. thick. It consists of five pieces—two 3½ in. by ¾ in. (A), two 2½ in. by ¾ in. (B), and one 2½ in. by 3½ in. (C). This forms a box without a lid, out of the bottom of which a circular hole is cut 1½ in. diameter (D). This will afterwards be the front of the shutter. Fig. 215 is drawn out of proportion to show the details more clearly. The parts are glued together, but the side containing the groove is not fitted at present, but has to wait for the completion of rollers. The top roller is formed of wood, as shown in Fig. 216; through the centre runs a square wire, A, rounded on each projecting piece, and on its end is attached a small pinion, B. Its greatest length is 3 in.

The bottom roller shown in Fig. 217 is the same length as the top roller, but consists of a brass cylinder $\frac{7}{16}$ in. in diameter, containing a spring. This roller, in principle, is the same as an ordinary spring-blind roller. In Fig. 217, A is the centre rod; B B, wire spring; C, screw-thread to take F; D, end of cylinder; E, cuts through which end of wire is fastened; F, winding knob; G, hole through which wire is fastened to rod; and H, cylinder. About 4 ft. of the best round steel wire will be required for the spring. The end D goes inside the tube, and is $\frac{3}{16}$ in. thick. Dents made with a sharp tool round the edge of the cylinder will hold the end fast, or the edge may be turned down. Probably amateurs would do well to purchase the roller ready made. The blind, Fig. 218, p. 146, is made of thin black rubber cloth, 10 in. long by 2 in. wide; in the middle is an opening $1\frac{1}{2}$ in. square. Suitable cloth for the blind, as well as sheet rubber to assist in tightly fitting to lens hood, could be obtained from any large dealers in rubber. The rubber cloth may be glued to the top roller, but for extra strength is bound round the wire and brought out through a slot in the wood roller. The other end (marked "set") is bound round the bottom roller. A piece of fine silk cord is threaded through the hole in the pulley at top (Fig. 216), and brought down the side and out through F, being guided by the groove, E (Fig. 215). The silk cord is about three times as stout as that used for eyeglasses.

The outside works next require explanation. It will be seen that if the cord is pulled some means of resistance is required to hold the blind at the point when the opening in the blind reaches D (Fig. 215), for focussing, etc., and also when "set" reaches D. To do this, a cog-wheel (Fig. 219) is fixed into the teeth in the pinion, having in its side three projections, A, B, C (the use of C will be seen later on). The catches, A, B, are so placed as to meet cut A (Fig. 220) at both the required points. There are six teeth in the pinion (B, Fig. 216), and thirty-three teeth in the cog-wheel, 5, Fig. 214. This cog-wheel has generally an extra plate of thin brass shape l as shown in Fig. 221, upon which it runs in order to bring it well up into the teeth of the pinion, but this is not essential. The number of teeth also is not an important matter, the great thing being to have the catches in the right place, which is best found by practical test.

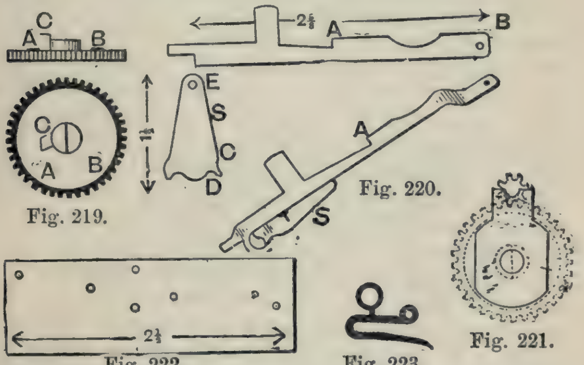


Fig. 219.—Cog-wheel; Fig. 220.—Metal Arm and Spring, Fig. 221.—Cog-wheel and Brass Plate; Fig. 222.—Brass Supporting Plate; Fig. 223.—Spring and Thumbscrew.

To return to Fig. 215, the remaining side is put in, but as a basis for the outside works a sheet of ⅛-in. brass, length 2½ in. (Fig. 222), is first screwed to it. The cog-wheel, with catches (Fig. 219), can now be fitted well into the teeth of the pinion. The metal arm (Fig. 220) is now formed, as is also the spring, S, to which it is attached. The arm shown in Fig. 220 is of blackened brass, and the under spring or guiding plate is also of brass, but this is best left plain; these, however, are points which affect the appearance rather than the working of the shutter.

Observe that the spring, S (Fig. 220), is bent at C, and that it has cuts, D, ⅛ in., and screw-hole, E. The cuts hold in position the arm by means of the bent piece, F (see also Fig. 214, p. 146). In fitting the metal arm and spring to the shutter, the screw, B, should be left slightly loose, so that the arm may be slid aside for time exposures; as regards the catch, C (Fig. 219), stop the wheel midway and keep the shutter open till ball is released, when the catch flies over the top again. By referring to Fig. 214, p. 146, it will be seen that under the projecting arm is a rubber bulb, which when inflated lifts the arm above the first catch, or causes it to come in contact with the other, according to the position of the arm. This bulb, together with tube and ball, is next fixed. If an attempt be made, however, to set the shutter at this point, it will possibly be found that the spring roller requires winding up to give sufficient strength. This necessitates the second brass plate, ¾ in. square, over this, and on to the rod screws a thumbscrew, out of the side of which a piece is cut, and into the opening the spring locks after each revolution. The position of the spring and thumbscrew is shown in Fig. 223. The spring which connects with the thumbscrew may be made of flattened steel wire, but must be hard and strong. It now needs only the wood, shaped as in Fig. 224, to be fastened in by screws, G, G, G. The opening C (Fig. 224) for the lens is lined with rubber. Fig. 214, p. 146, will now be more intelligible. The numerals in that figure are explained thus: No. 1, wooden outer case or framework; 2, top roller pinion; 3, bottom roller; 5, cog-wheel; 6, metal arm; 7, brass standard; 8, spring; and 9, back portion of framework.

To test the speed of a shutter, photograph a small bright object attached to a wheel revolving at a known speed. With compasses, measure the arc formed by this bright object during a revolution of the wheel, subtract the width of the image of the object when at rest, and find the proportion to the whole circle. The speed at which the wheel is travelling being known, the length of the arc shows the duration of exposure. For example, fix a small piece of tinfoil to the outer edge of, say, the front wheel of a bicycle, and place it in the sunshine against something very dark, so that the tinfoil may reflect as much light as possible. Focus the wheel exactly 3 in. diameter, near the top of the ½-plate (a circle that size may be drawn in pencil on the focussing screen as a guide); set the shutter at its lowest speed and cause the wheel to revolve rapidly. See how many complete revolutions it makes in ten seconds. If possible, it should be made to go round ten times exactly; but, supposing it only goes eight, then it will make one revolution in $\frac{5}{4}$ sec. Release the shutter immediately, close the slide, and move the camera slightly, so that the image comes ¼ in. lower. Rotate the wheel at exactly the same speed as before, and again release. Proceed in this way with each of the various speeds of the shutter, and then develop the plate. A circle should be drawn 3 in. in diameter, and the several arcs shown on the plate measured, the width of the image of the tinfoil at rest subtracted, and the result divided into the circumference. If the first goes 10 times, then the speed will be $\frac{1}{10}$ of $\frac{5}{4}$ sec., or $\frac{1}{8}$ sec. Shutters work slower as the springs wear; these should be let down after use. Speeds frequently are over-stated when sent out.

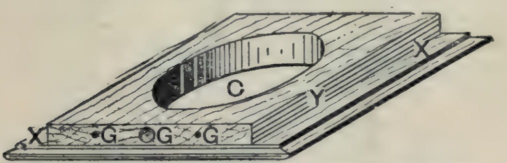


Fig. 224.—Back Portion of Shutter Framework.

For accurately testing and timing shutters, there is nothing simpler than the Peal device shown by Fig. 225. An ordinary deal box, A, is divided down the centre, E; in the front is a cardboard dial, K, and running smoothly from back to front is a knitting needle, B, to which a wooden hand, C, is attached, having at its extremity a silver bead, D. The dial is divided into 100 parts, and the hand is made to describe a circle twice in a second. To regulate the speed, the needle passes through a cork, H, on either side of which is fastened a piece of card, F, accurately balanced. The rotating power is a length of worsted or silk cord, I, wound a few times round the needle; to one end is fastened a 4-oz. weight, J, and a smaller one to the other, the cords being kept apart by a drum, G. The time occupied in passing between two points is noted and the fans altered to give more or less resistance till this is exactly fifty seconds, during which time the hand should have made 100 revolutions.

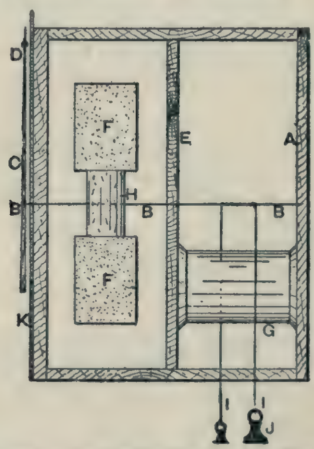


Fig. 225.—Peal's Shutter-timing Device.

CHAPTER X.

CAMERA TRIPOD STANDS.

THE description of how a four-fold camera tripod stand is constructed will enable anyone of intelligence to make stands of three or two folds only, as well as those of four folds; the modifications necessary in such cases are only slight and are self-suggestive. Studio stands are described in Chapter III.

The four-fold tripod illustrated by Fig. 226 is of light construction and very compact. For the legs, some laths of good American ash must first be cut to the following lengths and the edges slightly rounded off, care being taken that they are quite true and square, otherwise the tripod will not be rigid: Six pieces 17¼ by ⅝ in. by ⅜ in.; six pieces 16 in. by ⅝ in. by ⅜ in.; six pieces 15½ in. by ⅝ in. by ⅜ in.; three pieces 14 in. by ⅝ in. by ⅝ in.

First take one of the six longest pieces (17¼ in. by ⅝ in. by ⅜ in.) and at one end let in, flush with the wood, a piece of $\frac{1}{16}$-in. brass, 1¼ in. long by $\frac{5}{16}$ in. wide, having a $\frac{3}{16}$-in. hole drilled in it ¼ in. from the top; fix it to the wood wth two brass screws, countersunk, as shown in Fig. 227. An alternative is to have the brass plate as wide as the wood, as in Fig. 228, and perhaps this alternative is the more general plan. In Fig. 228, C is the plate screwed on and D is the hole which receives the pin, as explained later.

A hole to correspond with D or with the hole shown in Fig. 227 is bored in the wood directly under the hole in the brass, and the mouth slightly countersunk on the side opposite to that shown in Fig. 227. The top corners of the wood should be taken off, as shown. A groove is cut on the inner side (Fig. 227 shows the outer side) of the wood about $\frac{3}{16}$ in. deep and 3½ in. long; the groove begins 2 in. from the top end of the lath, and is $\frac{3}{16}$ in. wide for a length of 2½ in. from the bottom, and is then widened out to ½ in. for the remaining inch; the top is curved. At the bottom, the stretcher, a piece of ⅛-in. brass rod, is hinged by means of a pin passing through it into the wood on either side, so that the rod may be moved up and down or lie flat in the groove.

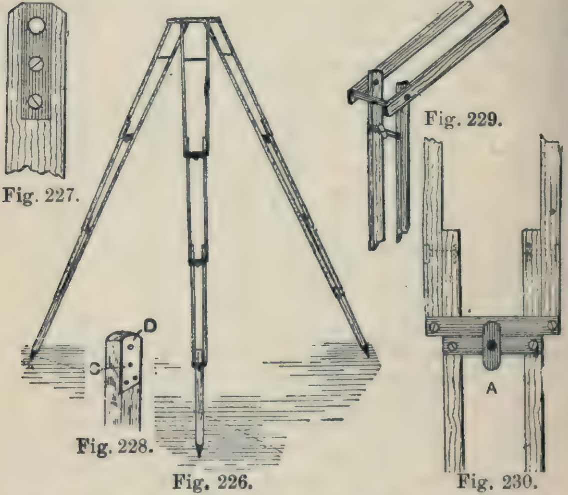


Fig 226.—Four-fold Tripod Stand; Figs. 227 and 228.—Tops of Legs; Figs. 229 and 230.—Leg Joints.

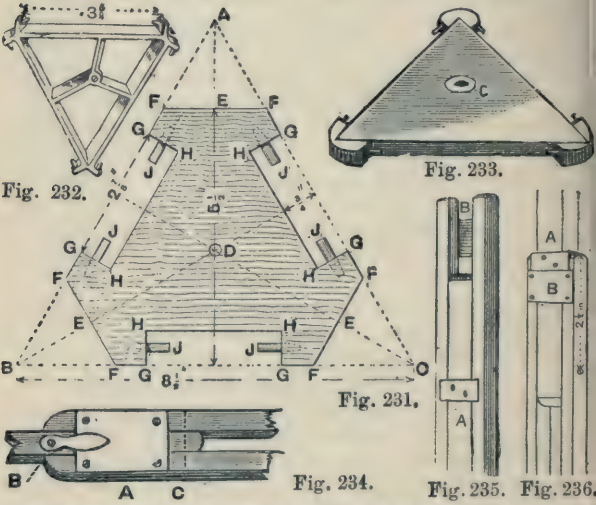
Another of the longest pieces is next fitted in a similar manner to the one just described, with the exception of the groove, which is only 1½ in. long and $\frac{3}{16}$ in. wide, and is cut curving inwards, with a slight hole at the bottom end. This will be easily understood when it is explained that this second strip of wood is opposite to the first piece, and the hinged brass rod on the latter slides in the groove of the second piece and catches in the hole at the bottom end.

At the lower end of each of the longest laths and in the outer side is bored a ⅜ in. hole, 1¾ in. from the end and of sufficient depth to allow the head of a copper rivet being let in flush with the surface; the hole is then continued through the wood ⅛ in. in diameter to receive the stem of the rivet.

Next take two of the strips 16 in. by ⅝ in. by ⅜ in., and bore holes for the rivets, as previously described, at distances of ½ in. and 1¾ in. from the respective ends. Two of the strips 15½ in. by ⅝ in. by ⅜ in. are then bored in a similar manner and at the same distances from the ends. The above describes the treatment for each of the three pairs of laths. Lastly one of the three pieces 14 in. by ⅝ in. by ⅝ in. is bored with an ⅛-in. hole ½ in. from one end, the opposite end being tapered and fitted with a pointed iron shoe, or with steel point and ferrule.

The twenty-one strips of wood are now put together in three sets, each set forming a leg. The joints are made with ⅛-in. copper rivets and washers as follows: To the inner side of each of the 17¼-in. pieces rivet one of the 16-in. pieces through the hole bored in the latter at ½ in. from the end, and to the inner side of each of these two last strips rivet one of the 15½-in. pieces also through the hole bored in the latter at ½ in. from the end (see Fig. 229). The rivets must not project above the surface of the wood. The two treble-jointed legs thus obtained are next placed on their edges opposite each other, and across the bottom ends of the two top pieces is screwed a strip of $\frac{1}{16}$-in. brass 2⅞ in. long by ⅜ in. wide (see Fig. 229). Across the bottom ends of the two second strips screw a similar piece of brass 2⅛ in. long; and, lastly, across the bottom ends of the two third pieces screw a piece of brass 1⅜ in.

long. The single bottom leg fitted with the iron shoe may now be riveted in between the last two pieces. But before the whole leg is complete a strip of $\frac{1}{16}$-in. brass has to be screwed across the upper ends of the second and third pieces just under the strips already fixed, each being fitted with a brass button, A, Fig. 230, about $\frac{3}{4}$ in. long and $\frac{3}{8}$ in. wide



Figs. 231 to 233.—Stand Tops; Figs. 234 to 236.—Leg Joints.

riveted to the centre. The button may be turned round for the purpose of catching over the first strips of brass and thus locking the leg. To fix the bottom single leg, screw on a small piece of brass just below the last strip, in a similar manner to the others.

One of the three legs of the tripod now is complete, and the remaining two are made in exactly the same manner. The rivets must be just tight enough to permit of the legs folding up, but they must not be loose.

When all three legs have been made, the top remains to be cut out to the shape shown by Fig. 231, and the easiest way to do this is first to plane up a piece of ash to a thickness of ½ in., and then to draw on it an equilateral triangle, A B C, having 8½ in. sides. Bisect each of the angles, and the bisecting lines will meet in the centre of the triangle, D. Along each bisecting line measure from the corners a distance of 2 in. to E and draw lines at right angles. Where the last lines drawn touch the triangle (F), measure ½ in. inwards along the sides to G, and between these points draw three rectangles 2⅞ in. long and ¾ in. wide (G H H G). The outline of the top, as shown in solid lines in Fig. 231, will thus be obtained, and may then be cut out. A piece of $\frac{3}{16}$-in. brass rod, J, with one end slightly tapered, now is fastened in the sides of each rectangle, projecting about ½ in., the hole being bored ⅜ in. from the outer edge; a ¼-in. hole is bored through the centre of the top or triangle to take the camera screw; a piece of felt glued to the top will complete the tripod. Glasspaper and varnish the wood, and lacquer the brass work.

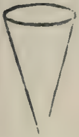
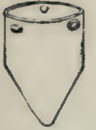


Fig. 237.


Fig, 238.

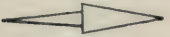


Fig. 239.

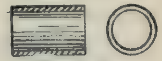


Fig. 241.

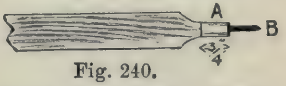


Fig. 240.

Figs. 237 and 238.—Stand Shoes; Figs. 239 and 240.—Points or Spikes; Fig. 241.—Ferrule.

There are several modifications possible in the details of the tripod. As regards the top, for instance, a brass casting may be used, as Fig. 232; or it may be of wood cut in the form of a triangle and corner-pieces added, the brass or steel points projecting from these corner-pieces (see Fig. 233).

The joints also of the legs are subject to variety Fig. 234 illustrates an arrangement designed on the same principle as the one already described. In making such a joint, each of the two long pieces is placed beside the shorter one, overlapping 5 in., as in Fig. 234, a stout screw, C, is put through the three laths 1 in. from the end of the shorter one, and the point of the screw is filed level with the wood. This screw acts as a pivot, and permits the legs to be folded. A plate of brass, A, 2¼ in. long and 2 in. wide, is let into the outer pieces and attached by screws, the wood in the shorter leg being cut away to the depth of the thickness of the plate, so that when the legs are opened out the plate will be flush with the surface of the wood; a button, B, is screwed loosely to the shorter leg, and by turning it the whole is kept rigid and firm.

In the joint illustrated folded up by Fig. 235 and opened out straight by Fig. 236, the middle lath has a plate wider than itself screwed on it, see A. Connecting the two outer laths ⅝ in. from their ends is the plate B. The middle lath or lower leg is slotted, and through the slot passes a screw fixed in the outer laths, the middle lath pivoting on the screw with plenty of play. When unfolding the joint, th lower leg is made to hang loosely in a straight li with the upper ones, and it is then pushed up, t slot in its end allowing this movement. Then the plate A will just cover the ends of the upper lath and the joint will be quite rigid (see Fig. 236).

The bottoms of the lower legs may have either shoes or points; they are little cones as a rule; Figs. 237 and 238 give an idea of their shape, whils the points or spikes may resemble Fig. 239; or ma be ordinary wide nails with the heads cut off, as in Fig. 240, in which A denotes the ferrule and B the nail point. The ferrules are of the usual shape, as shown by the plan and section, Fig. 241.

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